MARYLAND GEOLOGICAL SURVEY

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EOCENE

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1901

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LETTER OF TRANSMITTAL

To His Excellency John Walter Smith,

Governor of Maryland and President of the Geological Survey Commission.

Sir:—I have the honor to present herewith the first volume of a series of reports dealing with the systematic geology and paleontology of Maryland. A clear comprehension of our geological formations is based on a knowledge not only of the materials out of which the strata are composed, but also of the remains of animal and plant life which are entombed in the rocks themselves. A thorough knowledge of both these factors is essential as a basis for a complete interpretation of the mineral resources of the state, while the educational and scientific value of such information cannot be overestimated. It is the purpose of the Survey to publish a number of similar reports which will embrace the entire sequence of Maryland formations. Already much progress has been made in the investigations for the subsequent volumes of the series. I am,

Very respectfully,

William Bullock Clark,

State Geologist.

Johns Hopkins University,

Baltimore, *April*, 1901.

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PREFACE

The present volume is the first of a series of reports dealing with the systematic geology of Maryland. These reports will appear from time to time as the several investigations are completed, but not necessarily in geological sequence. By reference to Volume I of the Survey it will be seen that the geological sequence of Maryland rocks is as follows:

Cenozoic	Pleistocene Neocene Eocene
Mesozoic	Cretaceous Jurassic-Triassic
Paleozoic	Permian-Carboniferous Devonian Silurian Cambrian
Archean	Algonkian-Archean

Some of these divisions are more extensively developed in Maryland than others so that the contemplated reports will differ greatly in size. The oldest division, comprising the Algonkian-Archean, is entirely destitute of organic remains in Maryland, while the Jurassic-Triassic is nearly so. The other seven divisions, however, contain either rich faunas or floras; three of them, the Permian-Carboniferous, the Cretaceous and the Pleistocene containing both animal and plant fossils.

These reports when completed will give both to the geologist and to the general reader a comprehensive view of the past history of Maryland territory from the earliest geological period to the present day. For educational purposes the volumes cannot fail to have much value, and will find frequent use in the hands of those who are seeking to acquire a knowledge of the physical and faunal history of the State of Maryland.

The present volume on the Eocene deals with the earliest period of the Cenozoic and, with the Neocene, embraces what is frequently de-

nominated by geologists as the Tertiary. As will be shown in later pages the Tertiary rocks of Maryland are of wide extent and contain much of interest from both a scientific and practical standpoint.

The Eocene deposits of Maryland have received for many years the close attention of the senior author of this paper, and his observations have been supplemented recently by the work of the junior author. A report made by the senior author to the Director of the U. S. Geological Survey in 1896 is extensively drawn upon for the present volume, many of the general descriptions being taken directly therefrom, with such changes and additions as the present enlarged knowledge of the subject may require.

Dr. R. M. Bagg, Jr., also spent portions of two field seasons in a study of the local stratigraphy under the personal direction of the State Geologist and prepared a series of preliminary maps covering a large part of the area.

The paleontological investigations have been jointly conducted by several experts. In addition to the sections for which the authors of the report are personally responsible, aid has been rendered in others by several well-known students.

The Reptilia have been studied by Dr. E. C. Case of Milwaukee, Wisconsin; the Fishes by Dr. Charles R. Eastman of Harvard University, Cambridge, Massachusetts; the Crustacea and Bryozoa by Mr. E. O. Ulrich of Newport, Kentucky; the Corals by Mr. T. Wayland Vaughan of the U. S. Geological Survey; the Protozoa by Dr. R. M. Bagg, Jr., of Colorado Springs, Colorado; and the Plants by Dr. Arthur Hollick of Columbia University, New York. Mr. Charles Schuchert of the U. S. National Museum has revised the descriptions of the Brachiopoda.

Extensive collections of material were made preparatory to this work, and all the leading fossiliferous localities of the state were visited. The greatest amount of material was obtained, however, from the bluffs along the banks of the Potomac river, which afford the most complete section of the Eocene in the Middle Atlantic Slope. In general, the fossils of this region are difficult of removal, as they readily crumble at the touch, so that some process of hardening had to be employed to preserve them permanently. To this fact more than to any other cause, has been due

the small size of the collections of Eocene specimens found in the various museums of the country, as compared with the collections of Neocene forms from the same area. The forms figured and described in this report have come, with scarcely an exception, from the collections of the United States National Museum, the Academy of Natural Sciences of Philadelphia, the Johns Hopkins University, and the Maryland Geological Survey. The Museum of the Academy of Natural Sciences of Philadelphia contains Dr. Conrad's types, which have been most important in definitely determining the species hitherto described.

The State Geological Survey desires to express its thanks for the aid which has been rendered by the several experts who have contributed to this volume; also to the U. S. Geological Survey which has generously allowed the use of many of its plates and drawings, which have materially reduced the expenses of publication; and to Professor G. D. Harris for the loan of several drawings.

Many important suggestions have also been received from Dr. W. H. Dall of the U. S. Geological Survey, Professor H. A. Pilsbry of the Philadelphia Academy of Natural Sciences and Mr. C. W. Johnson of the Wagner Free Institute of Science. They have examined many of the determinations of fossils, and have thus materially contributed to the accuracy of the report.

Thanks are also due to the artists Mr. J. C. McConnell of the U. S. Army-Medical Museum, Mr. H. C. Hunter of the U. S. Geological Survey and Mr. F. von Iterson for the beautiful drawings with which the report is illustrated.

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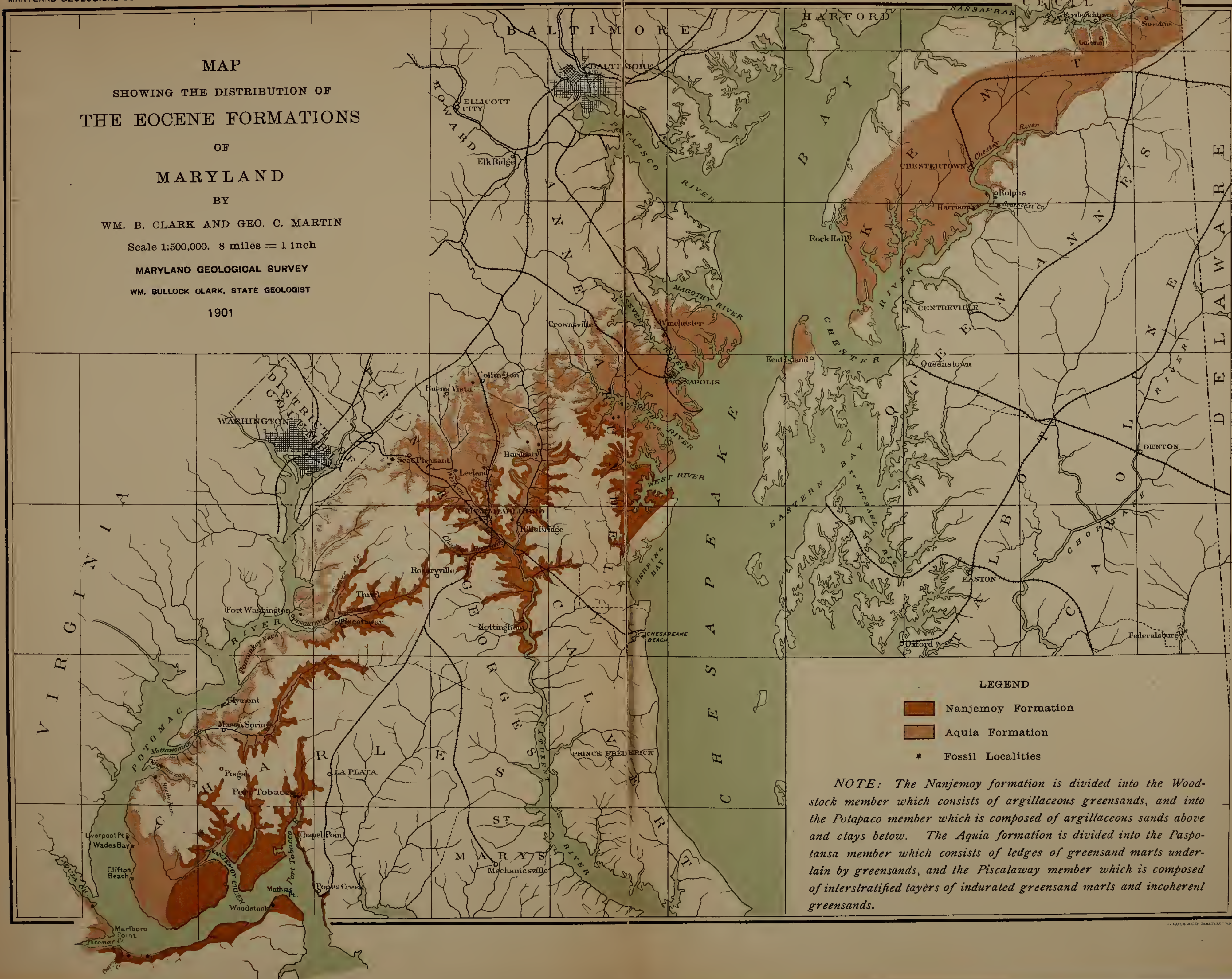
THE EOCENE DEPOSITS
OF MARYLAND

BY

WILLIAM BULLOCK CLARK

AND

GEORGE CURTIS MARTIN


MAP
SHOWING THE DISTRIBUTION OF
THE EOCENE FORMATIONS
OF
MARYLAND
BY
WM. B. CLARK AND GEO. C. MARTIN
Scale 1:500,000. 8 miles = 1 inch
MARYLAND GEOLOGICAL SURVEY
WM. BULLOCK CLARK, STATE GEOLOGIST
1901
LEGEND
Nanjemoy Formation
Aqua Formation
Fossil Localities
NOTE: The Nanjemoy formation is divided into the Woodstock member which consists of argillaceous greensands, and into the Potapaco member which is composed of argillaceous sands above and clays below. The Aquia formation is divided into the Paspotansa member which consists of ledges of greensand marls underlain by greensands, and the Piscataway member which is composed of interstratified layers of indurated greensand marls and incoherent greensands.
BALTIMORE
HARFORD
CECIL
HOWARD
ANNE ARUNDEL
PRINCE GEORGES
CALVERT
CHARLES
ST MARYS
KENT
QUEEN ANNES
TALBOT
CAROLINE
DISTRICT OF COLUMBIA
VIRGINIA
DELAWARE
CHESAPEAKE BAY
BALTIMORE
WASHINGTON
ANNAPOLIS
ELLICOTT CITY
Elk Ridge
Crownsville
Winchester
Collington
Buena Vista
Seat Pleasant
Leeland
Hardesty
UPPER MARLBORO
Hills Bridge
Rosaryville
Fort Washington
Piscataway
Nottingham
CHESAPEAKE BEACH
PRINCE FREDERICK
LA PLATA
Pisgah
Port Tobacco
Chapel Point
Mechanicsville
Popes Creek
Mathias Pt.
Woodstock
Liverpool Pt.
Wades Bay
Clifton Beach
Marlboro Point
Glymont
Mason Springs
CHESTERTOWN
Rolphs
Harrisons
Rock Hall
CENTREVILLE
Kent Island
Queenstown
DENTON
EASTON
Oxford
Federalsburg
Fredericktown
Galena
Sassafras
PATAPSCO RIVER
MAGOTHY RIVER
SEVERN RIVER
SOUTH RIVER
WEST RIVER
HERRING BAY
CHESTER RIVER
EASTERN BAY
ST MICHAELS RIVER
CHOPTANK RIVER
PATUXENT RIVER
POTOMAC RIVER
NANJEMOY CREEK
Port Tobacco
Mattawoman

THE EOCENE DEPOSITS OF MARYLAND

BY

William Bullock Clark and George Curtis Martin

Introduction.

Maryland, as an important division of the Atlantic border region, comprises in its geology and mineral resources much that is typical of the entire province. No discussion of Maryland geology, therefore, can be regarded as complete that does not at the same time take into consideration the formations of immediately adjacent states. Much may be learned in this way that will be of advantage in interpreting our own geology, since geological deposits are not limited by political boundaries.

Maryland, together with Delaware and Virginia, forms what has with propriety been termed the Middle Atlantic Slope, and, as described in the earlier volumes of the Survey, has been divided into the Coastal Plain, the Piedmont Plateau, and the Appalachian Region. The present report is confined to a consideration of only a part of the first of these divisions.

Much interest has been manifested in the Coastal Plain geology and paleontology of the Middle Atlantic Slope since the early days of geological investigation in this country. Many of the most potent illustrations of the geologists of the early part of the century were drawn from this region, and although the relations of the deposits were not altogether comprehended, yet the recorded observations show an appreciation of many of the more difficult problems involved. Later, as the complicated geological history of the Coastal Plain became better known, it was recognized that, if a full understanding of any single formation was to be gained, it was necessary to study carefully not only its lithological and paleontological characteristics but also its relationship to

the other members of the series. It was seen that only by an understanding of the broad conditions affecting the whole district could the strata of any one formation be properly interpreted. Recognizing this fact, the writers present in later pages a brief discussion of the general relations of the strata composing the Coastal Plain in the Middle Atlantic Slope. The fuller discussions will be found in the later volumes dealing with these formations.

When we come to consider that assemblage of deposits (Eocene and Neocene) early separated as the Tertiary, we find that it is divisible into several distinct formations. Even at a relatively early date an older and a younger Tertiary were already established, the former being correlated with the Eocene of England and the European continent. Attempts were made then and later to find its exact equivalent in one or another of the already established local formations of the English or continental series, but with very unsatisfactory results.

After the American Eocene strata had received somewhat detailed examination in the various sections of the country and local divisions had been established, attempts were made from time to time to determine their equivalency. By common consent the diversified and extensive deposits of the Gulf area came to be regarded as the type for the eastern border region, and the various Eocene deposits of the Atlantic Coast States were assigned to positions in this series. Some authors, recognizing the presence of a few identical species, have referred the strata now under consideration to a single minor division in the scale, while others have regarded the Maryland-Virginia deposits as representing a larger portion of the Gulf series. After a careful consideration of both the paleontological and the geological data, the writers deem the latter conclusion the only tenable one.

Attention has been devoted in the past too exclusively to supposed faunal similarities, upon the most insufficient knowledge of the forms, and too little to the character of the sedimentation. Important as the former are when the fauna has been fully investigated, and the writers would be far from disparaging that importance, yet the widely different physical conditions surrounding the accumulation of the deposits in the two areas must at the same time be regarded. Change in a fauna is

not to be measured by the time standard alone, but also by the conditions of life, whether constant or variable, to which the forms may be subjected. Persistent conditions must of necessity have less effect than those which are changing. A satisfactory correlation of the strata in districts so widely separated as the Middle Atlantic Coastal Plain and the Gulf Region can be attained only by a proper appreciation of the bearing of these factors on faunal development.

In the Middle Atlantic Slope the relatively homogeneous nature of the Eocene deposits is a characteristic feature, indicating that throughout the period of deposition the conditions were undisturbed by important physical changes. The fact that the deposits are made up largely of secondary materials shows in a general way that their accumulation took place near a coast reached by few large sediment-bearing rivers, and that at the same time the place of deposition was sufficiently removed from the coast line to be unaffected by shore conditions. In the Gulf Region, on the other hand, deposition was more rapid, since a great quantity of detrital material was brought to the sea by the large streams draining the interior of the continent. The bearing of these different physical conditions upon the interpretation of the two areas and the correlation of their deposits will be fully considered in the body of the report.

The materials of the Eocene of the Middle Atlantic Slope, which are so largely glauconitic, are of no little interest in themselves outside of their bearing upon the questions of correlation, since few areas afford such extensive deposits of greensand. On that account alone they deserve special consideration, and a chapter will be devoted to this phase of the subject.

The description of new species of fossils is of little scientific importance to the geologist unless the object is something other than the mere multiplication of new forms, which has too often been the case in such investigations. When, however, the work has in view the fullest possible representation of a fauna or the clearing up of doubtful points in the synonymy of already described species, as well as a more complete knowledge of their geological and geographical ranges, it becomes of the very greatest value, since one whole class of important criteria for

the interpretation of the strata is thus made accessible. The present report includes the results of such an exhaustive study of the fauna of the Eocene of Maryland, together with a critical review of the species described by previous authors, as well as the description of a large number of new forms. It is believed that a much more accurate idea of the faunal characteristics, as well as of the physical conditions prevailing during the Eocene period on the Middle Atlantic Coast, will result from the methods pursued in this investigation. Certainly the data for the comparison of the fauna with those of other areas will be greatly augmented.

Historical Review.[1]

On account of its extensive waterways and the ready access thereby gained, the Atlantic Coastal Plain was early visited for purposes of geological investigation. At first the observations were of the most general character, no attempt being made to differentiate the deposits or even to correlate the strata as a whole with those of other districts.

Among the earliest investigators of the region was Professor Peter Kalm, who was sent out in 1749 under the auspices of the Swedish Royal Academy of Sciences to make a study of the various branches of natural history in America, and who spent considerable time in a study of the northern Coastal Plain.

He was followed in 1777 by Dr. Johann David Schöpf, of Germany, who visited America in order to study the geological features of the eastern portion of the continent. The importance of his observations, which mark considerable advance over those of Kalm, has not been very generally recognized by later writers, but he showed a remarkably keen insight into the geology of eastern North America, which was lacking on the part of some of his successors.

The first attempt to correlate the deposits of the eastern United States with the geological column then established in Europe was made by William Maclure, in 1809, in his Observations upon the Geology of the

[1] Both in this and in the subsequent chapter, comprising the Bibliography, references are made to articles and books dealing also with the Eocene of Delaware and Virginia since the deposits are embraced in the same geologic province with those of Maryland.

United States. In this publication the coastal deposits of the Middle Atlantic Slope are collectively referred to the "Alluvial formation," the fourth of the main divisions of geological strata originally proposed by Werner. The work was subsequently revised and enlarged, appearing in book form in 1817.

In 1820 H. H. Hayden, of Baltimore, published a volume of Geological Essays, in which he attempted to explain the great accumulation of "alluvial deposits" in the Atlantic Coastal Plain. In this volume the stratigraphy of the region is described in much greater detail than by his predecessors, and reference is made to the wide distribution of fossil shells and vertebrate remains, many localities being cited.

A volume of the same character, so far as it relates to the geology, was published in 1822 by Parker Cleaveland, entitled an Elementary Treatise on Mineralogy and Geology, in which, on page 785, under remarks on the "Geology of the United States explanatory of the subjoined geological map," the limits and the lithological character of the "alluvial deposits" are described in general terms.

By far the most important contribution to the stratigraphy of the Atlantic Coastal Plain that had up to that time appeared was made by Professor John Finch, in a "Geological essay on the Tertiary formations in America," in the American Journal of Science and Arts for 1824. This was the first attempt at a division of the deposits of the Coastal Plain and their correlation upon scientific grounds; and although thus early in the history of the subject detailed comparisons (which are always unsatisfactory) were made, yet the knowledge of the formations was materially advanced. The author says:

> In America an immense tract of country, extending from Long Island to the Sea of Mexico, and from 30 to 200 miles in width, is called an alluvial formation. From an examination of fossils brought from that quarter of the United States, from a personal inspection of some of its strata, and the perusal of most of the publications which bear a reference to it, I wish to suggest that what is termed the alluvial formation in the geological maps of Messrs. Maclure and Cleaveland is identical and contemporaneous with the newer Secondary and Tertiary formations of France, England, Spain, Germany, Italy, Hungary, Poland, Iceland, Egypt and Hindostan.

The deposits of various portions of the Middle Atlantic Slope are considered in greater or less detail, and correlations with the strata of

other portions of the Coastal Plain and with Europe are attempted. The author states in short that—

> Many more instances might be advanced to establish the identity of what has been called the alluvial district in America with the Tertiary formation of England and the continent of Europe. The fossil shells from the various beds would not, perhaps, be exactly like those of Europe, but a sufficient number would be found so to establish their relation and order of succession.

During the year 1825 Jer. Van Rensselaer delivered in the New York Athenaeum a course of geological lectures that were subsequently published in book form. The author adopted the classification proposed by Finch, confining his descriptions, however, more particularly to the formations of the northern Coastal Plain.

The American Journal of Science for 1826 contains a communication by James Pierce "On the shell-marl region of the eastern parts of Virginia and Maryland," in which reference is made to the sections on the James and Potomac rivers and to the "shell rock" at Upper Marlboro.

A few years later (1828) Professor Lardner Vanuxem, through his friend, Dr. S. G. Morton, presented the criteria for a more complete and definite recognition of the several members of the coastal series, and described both the Cretaceous and Tertiary formations. In this article an attempt is made to define more accurately the limits of the Tertiary. The author states that much that had been designated by that name properly belongs to other formations.

Up to the year 1830 all investigations of the stratigraphy of the Tertiary had been carried on in the main independently of a study of the fossils. Generic identity had been cited as ground for correlation, and although this aided largely in determining the limits of the Tertiary itself, further subdivisions were impracticable.

The publication of Conrad's article "On the geology and organic remains of a part of the peninsula of Maryland," with an appendix containing descriptions of new species of fossil shells, inaugurated a new era in the investigation of the Coastal Plain strata. It is true that Say had already described several Tertiary species, including the common *Ostrea compressirostra* of the Eocene of the Middle Atlantic Slope, but, as stated in Conrad's paper, he did not "draw any geological inferences

from the organic remains examined." Conrad from the first applied the paleontological evidence he had acquired to an interpretation of the stratigraphy; and, although many of his conclusions were erroneous, the knowledge of the geology of the Coastal Plain was very materially advanced by his work. In this first paper such well-known early Tertiary forms as *Turritella mortoni*, *Cucullaea gigantea*, and *Crassatella alaeformis* are figured and described, while the presence of *Venericardia planicosta* Lamarck is also noted. By the use of the data afforded by these investigations the strata at Fort Washington, were correlated with the London Clay of England.

In 1832 Conrad began the publication (in parts) of an important work entitled "Fossil shells of the Tertiary formations of North America." This and its companion volume upon the "Middle Tertiary," commenced some years later, must be regarded as the basis of all later work upon Amerienn Tertiary paleontology. In the earlier publication Conrad regarded the deposits in the vicinity of Fort Washington, as "Middle Tertiary," and correlated them with the London Clay and *Calcaire grossier* of Europe, and the Claiborne beds of Alabama.

Before the completion of Conrad's first work above mentioned Lea published his "Contributions to geology," in which a large number of Eocene fossils are described and the stratigraphy of the Tertiary of the Atlantic Coastal Plain is discussed. In this work the term Eocene is first applied to the American Lower Tertiary deposits, although the general position of the deposits had already been recognized by Conrad. The latter, however, in 1834, in his "Observations on the Tertiary and more recent formations of a portion of the Southern States," employs the term Eocene for the Fort Washington deposits, although he there regards them as younger than the Claiborne beds, and even suggests their Miocene age.

During the same year Professor William B. Rogers made his first contribution to the Eocene geology of Virginia, and although this article contained little of real importance, it is of interest as being the first of a series of important publications upon the geology of Virginia.

Dr. S. G. Morton, whose investigations were chiefly confined to the Cretaceous, gives in his "Synopsis, etc.," published at this time, a

"Catalogue of the fossil shells of the Tertiary formations of the United States," in which many of the Middle Atlantic Slope forms are included.

During the year 1835 several important contributions were made to the geology of the Atlantic Tertiary region. Conrad published his investigations upon the Maryland-Virginia Tertiary area, including the description of two new species of Eocene fossils. Rogers presented "Further observations on the greensand and calcareous marl of Virginia," in which the lithological similarity of the beds to the greensand deposits of New Jersey is dwelt upon, although he believes that the character of the organic remains shows the strata to be Eocene. Jointly with his brother, H. D. Rogers, he presented to the Philadelphia Academy of Natural Sciences the first portion of "Contributions to the geology of the Tertiary formations of Virginia," in which several new species of Eocene fossils are described.

While the investigations hitherto mentioned were being carried on privately, the three states constituting that portion of the Middle Atlantic Slope now under consideration, viz., Delaware, Maryland, and Virginia, became aroused to the importance of official geological surveys of their areas.

The first to organize such a survey was Maryland, in 1833, J. T. Ducatel being appointed State Geologist. Reports were published until 1841, but the information they contain is economic rather than stratigraphic.

The Geological Survey of Virginia began operations in 1835, under William B. Rogers as State Geologist, who was thus able to continue much more systematically than hitherto his observations upon the Tertiary belt. The first report, for 1835, which contains a general statement regarding the "Eocene marl district," and most of the subsequent annual reports, which were continued until 1841, include more or less detailed descriptions of the Eocene deposits. Collectively they form the chief source of information regarding the Eocene stratigraphy of Virginia.

The Geological Survey of Delaware was short lived. Its investigations, under the direction of I. C. Booth, State Geologist, extended only over the seasons 1837 and 1838, for which years annual reports were

published, and, in addition, a more exhaustive "Memoir" in 1841; but in none of these publications was the Eocene recognized as such.

Conrad, who actively continued his investigations, made an important contribution to the Eocene of the Middle Atlantic Slope in 1842 in his "Observations on a portion of the Atlantic Tertiary region, with a description of new species of organic remains."

During this year the first of Lyell's publications upon the eastern Tertiary belt appeared in the Proceedings of the Geological Society of London. His conclusions were derived from personal observations, and were of special value from his wide knowledge of the Tertiary of Europe. He succeeded in explaining many points in American Tertiary stratigraphy hitherto imperfectly understood. The narrative of his first report contains the following statement:

Having examined the most important Cretaceous deposits in New Jersey, Mr. Lyell proceeded in the autumn of 1841 to investigate the Tertiary strata of Virginia, the Carolinas, and Georgia, with a view to satisfy himself, first, how far the leading divisions of Tertiary strata along the Atlantic border of the United States agree in aspect aud organic contents with those of Europe; and, secondly, to ascertain whether any rocks containing fossils of a character intermediate between those of the Cretaceous and the Eocene beds really exist. The conclusions at which he arrived from his extensive survey are given briefly as follows: (1) The only Tertiary formations which the author saw agree well in their geological types with the Eocene and Miocene beds of England and France; (2) he found no secondary fossils in those rocks which have been called Upper Secondary and supposed to constitute a link between the Cretaceous and Tertiary formations.

The Eocene deposits upon the James River, Virginia, are described in this paper. In his subsequent papers bearing upon the Eocene of the Middle Atlantic Slope the stratigraphy of the Eocene is further considered and references are made to other localities which he visited.

Murchison, in his presidential address before the Geological Society of London in 1843, reviewed the results of Lyell's investigations in America and added his own interpretation of a few points.

During the years immediately subsequent to Lyell's visit many important articles upon the Tertiary appeared from the pens of American geologists, although the publications dealt more largely with the southern than the northern deposits. Conrad, however, made additional observations upon the Eocene strata of the Middle Atlantic Slope and

described a number of new species. About this time Henry C. Lea published a "Catalogue of the Tertiary Testacea of the United States," in which the Middle Atlantic Slope forms are included.

Subsequent to 1850 interest in the Tertiary geology of the Middle Atlantic Slope seems for a time to have waned, and during the next twenty-five years very few investigations were carried on within the district. In Maryland two surveys, partly of a geological but more largely of an agricultural nature, were inaugurated, the first, under James Higgins, producing six reports between 1850 and 1858, and the second under Philip T. Tyson, who presented two reports in 1860 and 1862. In the report for 1860 the Tertiary is described in some detail, although no attempt is made to establish the limits of its several divisions.

Conrad continued, however, to carry on his investigations upon the Atlantic Tertiary belt, adding to the number of new fossil forms and publishing two catalogues of species.

During the last twenty-five years, and particularly in the latter part of this period, many more contributions have been made to the geology of the Middle Atlantic Slope. Among those who have given the subject attention may be mentioned McGee, Heilprin, Darton, Uhler, Shattuck, Bibbins, Harris and the authors of this report. To the publications of McGee we are indebted more than to any other for a general statement of Coastal Plain conditions. Although some modifications have been deemed necessary after a detailed study of the formations, the writers are impressed, from a careful examination of large portions of the area, with the general correctness of the broad principles enunciated by him. Heilprin has devoted considerable attention to Atlantic Coast paleontology, comparing several of the Eocene species of Maryland and Virginia with European forms, and correlating the strata, as a result of these investigations, with the lower members of the English and French series. Both Darton and Uhler have studied the local relations of the Eocene deposits, the former having prepared several United States Geological Survey atlas sheets of the central and southern portions of the district.

Others have turned their attention from time to time to the area, and from their knowledge of other districts have aided to a greater or less

degree in interpreting the geology of the Eocene of Maryland. The articles contributed by all the various workers in this field are given in the bibliography.

Bibliography.

ALDRICH, T. H. Notes on Eocene Mollusca.

Bull. Amer. Pal., vol. ii, No. 8.
Crassetalla declivis Heilprin and *Ringicula dalli* Clark are figured.

BAGG, R. M. JR. Contributions to the Eocene fauna of the Middle Atlantic Slope. Protozoa.

Johns Hopkins Univ. Circ., vol. xv, 1895, p. 6.
Spiroplecta clarki is described from Woodstock, Virginia.

——— The Eocene Deposits of the Middle Atlantic Slope in Delaware, Maryland and Virginia. Protozoa.

Bull. 141, U. S. Geol. Survey, 1896, pp. 91, 92.
A list of Eocene Foraminifera is given.

——— The Tertiary and Pleistocene Foraminifera of the Middle Atlantic Slope.

Bull. Amer. Pal., vol. ii, No. 10, 1898, pp. 295-348 (1-34), pls. xxi-xxiii (i-iii).
Several Eocene species are figured and described.

——— The occurrence of Cretaceous fossils in the Eocene of Maryland.

Amer. Geol., vol. xxii, 1898, pp. 370-375.
The author mentions the occurrence of *Terebratula harlani* and *Gryphaea vesicularis* in the Maryland Eocene.

BAILEY, J. W. Notice of some New Localities of Infusoria, Fossil and Recent.

Amer. Jour. Sci., vol. xlviii, 1845, pp. 321-343, pl. iv.
Mentions occurrence of casts " in some of the Eocene marls from Fort Washington."

——— On the Origin of Greensand, and its formation in the oceans of the present epoch.

Amer. Jour. Sci., 2nd ser., vol. xxii, 1856, pp. 280-284.
Proc. Bost. Soc. Nat. Hist., vol. v, pp. 364-368.
Author again refers to " casts " found in Fort Washington Eocene.

BASSLER, RAY S. and NICKLES, JOHN M. A Synopsis of American Fossil Bryozoa.

Bull. 173, U. S. Geol. Survey, 1900, p. 72.
Upper Marlboro is included in the list of Eocene localities.

Booth, J. C. Memoir of the Geological Survey of the State of Delaware, including the application of the geological observations to agriculture.

Dover, 1841, 8vo, xi and 188 pp.

The author gives a description of the Upper Secondary and Tertiary formations, but does not distinguish the Eocene.

Clark, William Bullock. On three geological excursions made during the months of October and November, 1887, into the southern counties of Maryland.

Johns Hopkins Univ. Circ., vol. vii, 1888, pp. 65-67.

Reference is made in this article to the Eocene of Upper Marlboro and Port Tobacco.

——— Third annual geological expedition into southern Maryland and Virginia.

Ibid., vol. ix, 1890, pp. 69-71.

The author describes the Eocene section of the Potomac river valley in Maryland and Virginia.

——— Report of the scientific expedition into southern Maryland.

Ibid., vol. x, 1891, pp. 105-109.

Much of the same areas are described in this report as in the preceding paper.

——— Correlation Papers—Eocene.

Bull. 83, U. S. Geol. Survey, 1891, pp. 43-48, 80, 81, 85-87.

The author gives a digest of the literature of the Eocene of the Middle Atlantic Slope, as well as a description of the deposits. Correlation is made with the lower and middle divisions of the Gulf series.

——— Outline of the geology and physical features of Maryland. The Eocene.

In Maryland, its Resources, Industries and Institutions, Baltimore, 1893, pp. 53-56.

In this report the author gives a brief description of the Eocene deposits of Maryland.

——— The climatology and physical features of Maryland.

First Biennial Report Md. State Weather Service, 1894, pp. 38-39.

Description of the same area as in the preceding report.

——— Contributions to the Eocene fauna of the Middle Atlantic Slope.

Johns Hopkins Univ. Circ., vol. xv, 1895, pp. 3-6.

This article contains a list and discussion of the Eocene species of Delaware, Maryland and Virginia, with the description of 32 new forms. The part upon Corals is prepared by Vaughan, that upon Foraminifera by Bagg.

——— The Potomac River Section of the Middle Atlantic Coast Eocene.

Am. Jour. Sci., 4th ser., vol. i, 1896, pp. 365-374.

A detailed section of the Potomac river section is given.

——— The Eocene Deposits of the Middle Atlantic Slope in Delaware, Maryland and Virginia.

Bull. 141, U. S. Geol. Survey, 1896, 167 pp. 40 plates.

A general discussion of the geological features, distribution, character and correlation of the deposits, with a description of the contained fossils. A number of new species are added.

——— Outline of present knowledge of the Physical Features of Maryland, embracing an account of the Physiography, Geology, and Mineral Resources.

Md. Geol. Survey, vol. i, 1897, pp. 195, 196, 217.

The Eocene deposits of the state are described.

——— Collection of Eocene Fossils.

Johns Hopkins Univ. Circ., vol. xviii, 1898, No. 137, p. 18.

The author substitutes the name *Pecten dalli* for *Peeten rogersi* which was already pre-empted.

Cleaveland, Parker.—An elementary treatise on mineralogy and geology. Remarks on the geology of the United States explanatory of the subjoined geological map, Boston, 1822, 785 pp.

The author defines the limits of the "alluvial deposits" and in general terms describes their lithological character.

Conrad, T. A. On the geology and organic remains of a part of the peninsula of Maryland.

Jour. Acad. Nat. Sci., Phila., vol. vi, 1830, pp. 205-217.

Reference is made to the deposits of Fort Washington and Piscataway, and correlation proposed with London Clay of England. The paper also contains original descriptions of *Monodonta glandula*, *Turritella mortoni*, *Cucullaea gigantea*, and *Crassatella alaeformis* from this region.

——— Fossil shells of the Tertiary formations of North America, 1832-1835, 56 pp. (including republication No. 3), 20 pls.

The author regards the deposits in the vicinity of Fort Washington as "Middle Tertiary," and correlates them with the London Clay, *Calcaire grossier* and Claiborne beds. He also describes *Cardita planicosta* and *Turritella mortoni* from Piscataway.

——— Observations on the Tertiary and more recent formations of a portion of the Southern States.

Jour. Acad. Nat. Sci., Phila., vol. vii, 1834, pp. 116-129.

Mention is made of the deposits of Fort Washington, which are considered younger than the strata at Claiborne, Ala., perhaps Miocene in age.

——— Observations on the Tertiary Strata of the Atlantic Coast.

Amer. Jour. Sci., vol. xxviii, 1835, pp. 104-111.

Author states that there are no Eocene species common to the Pliocene.

——— Observations on a portion of the Atlantic Tertiary region.

Trans. Pennsylvania Geol. Soc., vol. i, 1835, pp. 335-341, pl. xiii.

The deposits at Upper Marlboro and Piscataway, and City Point, Va., are considered, and *Panopaea elongata* and *Turritella humerosa* from Piscataway described.

——— Notes on American Geology. Observations on characteristic Fossils, and upon a fall of Temperature in different geological epochs.

Amer. Jour. Sci., vol. xxxv, 1839, pp. 237-251.

Refers to the Eocene deposits of Upper Marlboro and Piscataway as illustrations of deposition by gentle currents.

——— On the Silurian system, with a table of the strata and characteristic fossils. Observations on the Plastic Clay.

Amer. Jour. Sci., vol. xxxviii, 1840, pp. 91-92.

The authors discusses the relations of the Plastic Clay to the fossiliferous deposits at Piscataway, which it is regarded in some instances to overlie.

——— Observations on a portion of the Atlantic Tertiary region, with a description of new species of organic remains.

Proc. Nat. Inst. Prom. Sci., 2nd bull., 1842, pp. 171-194.

The deposits of Upper Marlboro, Piscataway and Fort Washington are referred to the Eocene or Lower Tertiary, and at the same time correlated with the London Clay, *Calcaire grossier*, Claiborne beds, etc. The author also describes *Ostrea sellaeformis* from City Point, Va., and *Pholadomya marylandica* and *Pholas petrosa* from Piscataway.

——— Observations on the Eocene formations of the United States, with descriptions of species of shells, etc., occurring in it.

Amer. Jour. Sci., 2nd series, vol. i, 1846, pp. 209-220, 395-405, pls. i-iv.

The article contains descriptions of *Pholas petrosa*, *Pholadomya marylandica*, *Panopaea elongata*, and *Crassatella alaeformis* from Piscataway, and *Crassatclla palmula* from Upper Marlboro.

——— Observations on the Eocene formation and descriptions of one hundred and five new fossils of that period from the vicinity of Vicksburg, Mississippi. With appendix.

Proc. Acad. Nat. Sci. Phila., vol. iii, 1847, pp. 280-299.

The author regards the Fort Washington, Piscataway and Upper Marlboro deposits as lower Eocene.

——— Observations on the Eocene formation and descriptions of 105 new fossils of that period from the vicinity of Vicksburg, Miss. Appendix: Descriptions of new Eocene fossils in the cabinet of Lardner Vanuxem.

Jour. Acad. Nat. Sci., Phila., 2nd series, vol. i, 1848, pp. 128-134, pl. xiv.

The author considers the Maryland and Virginia deposits as "Lower or older Eocene" and correlates them with the "fossiliferous sand of Claiborne and St. Stephens, Ala.," etc., chiefly from the presence of *O. sellaeformis*. He also describes *Cytherea subimpressa*, *C. lenis*, *C. liciata*. *C. eversa*, and *Nucula improcera* from Hanover County, Va.; *Cytherea pyga* from Stafford County, Va., and *Nucula parilis* from Upper Marlboro.

——— Notes on Shells.

Proc. Acad. Nat. Sci. Phila., vol. vi, 1853, p. 320.

Cytherea lenticularis Rogers is referred to the genus *Artemis* of Poli.

——— Rectification of the generic names of Tertiary Fossil Shells.

Proc. Acad. Nat. Sci. Phila., vol. vii, 1854, pp. 29-31.

The generic names of several Eocene fossils from Maryland and Virginia are changed.

——— Notes on shells, with descriptions of new fossil genera and species.

Proc. Acad. Nat. Sci. Phila., vol. xvi, 1864, pp. 211-214, with figures.

Descriptions are given in this article of *Protocardia virginiana* from Pamunkey River, Va., and *Dosiniopsis meekii* from "6 miles east of Washington, D. C."

——— Catalogue of the Eocene and Oligocene Testacea of the United States.

Amer. Jour. Conch., vol. i, 1865, pp. 1-35.

Among other forms the catalogue contains a list of the Eocene species of the Middle Atlantic Slope.

——— Descriptions of new Eocene shells and references, with figures, to published species.

Ibid., pp. 210-212, pls. xx, xxi.

The author describes *Lunatia marylandica*, but gives no locality.

——— Check list of the invertebrate fossils of North America (Eocene and Oligocene).

Smithsonian Misc. Coll., vol. vii, 1866, art. 6, pp. 1-41.

The Eocene species from the Middle Atlantic Slope are included in this list.

——— Descriptions and illustrations of genera of shells.

Proc. Acad. Nat. Sci. Phila., 1872, pp. 50-55.

The author describes *Latiarca idonea*, but gives no locality.

Dall, W. H. Contributions to the Tertiary Fauna of Florida, etc.

Trans. Wagner Free Inst. Sci., vol. iii, pts. i-v, 1890-1900, pp. 1-947.

The biological and geological relations of many of the Maryland and Virginia Eocene molluscan species are discussed.

——— A Table of the North American Tertiary Horizons correlated with one another and with those of Western Europe, with annotations.

18th Ann. Rept. U. S. Geol. Survey, 1898, pt. ii, pp. 325-348.

The Maryland Eocene is briefly discussed.

Dana, James D. Manual of Geology (fourth edition), 1895, p. 888.

Brief reference is made to the geology of the Middle Atlantic Slope.

Darton, N. H. Mesozoic and Cenozoic formations of eastern Virginia and Maryland.

Bull. Geol. Soc. Amer., vol. ii, 1891, pl. x, pp. 431-450.

The author gives a description of the Eocene deposits of Maryland and Virginia, and designates them the "Pamunkey formation."

——— Outline of Cenozoic history of a portion of the Middle Atlantic Slope.

Jour. of Geol., vol. ii, 1894, pp. 568-587.

The physical history during the Eocene period is briefly referred to, and the relationship of the deposits to earlier and later formations is stated.

——— Artesian well prospects in eastern Virginia, Maryland, and Delaware.

Trans. Amer. Inst. Min. Eng., vol. xxiv, 1894, pp. 372-379.

The lithological character of the strata is discussed and several deep borings are described.

——— Fredericksburg Folio, Virginia and Maryland.

U. S. Geol. Survey, Geol. Atlas, folio 13, Washington, 1894.

The author describes the Eocene deposits of the area.

——— Artesian Well Prospects in the Atlantic Coastal Plain Region.

Bull. 138, U. S. Geol. Survey, 1896, 228 pp., 19 plates.

Numerous Eocene sections are given.

——— Nomini Folio, Maryland and Virginia.

U. S. Geol. Survey, Geol. Atlas, folio 23, Washington, 1896.

The author describes the Eocene deposits of the area.

Ducatel, J. T. Annual reports of the geologist of Maryland from 1833 to 1841.

Annapolis, 8vo.

Only brief references to Eocene deposits, and those chiefly of an economic nature, are found scattered through the reports.

Featherstonhaugh, G. W. Geological Report of an examination made in 1834 of the Elevated Country between the Missouri and Red Rivers.

Washington, 1835, 8vo, 97 pp.

The author refers to the Eocene deposits of Maryland, especially the fossiliferous beds at Fort Washington and correlates them with "Lyell's Eocene."

Finch, John. Geological essay on the Tertiary formations in America.

Amer. Jour. Sci., vol. vii, 1824, pp. 31-43.

This article contains the first attempt at a differentiation of the "alluvial formation" of the Coastal Plain. The Tertiary is recognized.

Finch, J. Travels in the United States of America and Canada.

London, 1833, 8vo, 355 pp.

The author refers to the geology at Fort Washington.

Fontaine, W. M. Notes on the Mesozoic strata of Virginia.

Amer. Jour. Sci., 3rd series, vol. xvii, 1879, pp. 25-39, 151-157, 229-239.

The relations of the Eocene to Mesozoic strata are indicated.

——— The artesian well at Fort Monroe, Va.

The Virginias, vol. iii, 1882, pp. 18-19.

The Tertiary is regarded as having a thickness of 800 feet.

HARRIS, GILBERT D. Republication of Conrad's Fossil Shells of the Tertiary Formations of North America.

Washington, 1893, 8vo, pp. 1-121, pls. i-xx.

The republication of Conrad's important monograph on Tertiary Mollusca, for many years out of print, has rendered it now available to all paleontologists.

——— On the geological position of the Eocene deposits of Maryland and Virginia.

Amer. Jour. Sci., 3rd series, vol. xlvii, 1894, pp. 301-304.

The Eocene deposits of the Middle Atlantic Slope are correlated by the author with the Bell's Landing substage of the Lignitic of the Gulf.

——— The Lignitic Stage.

Bull. Amer. Pal., vol. ii, No. 9, 1897, pp. 193-294 (1-102), pls. vii-xx (i-xiv), and vol. iii, No. 11, 1899, pp. 1-22, pls. i-xii.

Many species found in the Maryland Eocene are described and figured.

HAYDEN, H. H. Geological essay, or an inquiry into some of the geological phenomena to be found in various parts of America and elsewhere.

Baltimore, 1820, 8vo, viii, 412 pp.

The general features of the "alluvial formation" of the Coastal Plain are described in this volume.

HEILPRIN, A. A comparison of the Eocene Mollusca of the southeastern United States and western Europe in relation to the determination of identical forms.

Proc. Acad. Nat. Sci. Phila., vol. xxxi, 1879, pp. 217-225.

Several forms known to occur in Maryland and Virginia are compared in this article with European species.

——— On the stratigraphical evidence afforded by the Tertiary fossils of the peninsula of Maryland.

Ibid., vol. xxxii, 1880, pp. 20-33.

The author calls attention to the few Eocene fossils in the Maryland strata, and the marked difference between the Eocene and Miocene faunas.

——— Note on the approximate position of the Eocene deposits of Maryland.

Ibid., vol. xxxiii, 1881, pp. 444-447.

The Maryland Eocene is regarded as "nearly equal to that of the Thanet sands of England and the Bracheux sand of the Paris Basin, or of the English Bognor rock (London Clay)." It is also correlated with deposits near the base of the "Buhrstone" or possibly even the "Eolignitic" of the Gulf.

——— North American Tertiary Ostreidae.

4th Ann. Rept. U. S. Geol. Surv., 1882-83, Washington, 1884, pp. 309-316. (Appendix I to C. A. White's Fossil Ostreidae of North America).

Gives *Ostrea compressirostra* Say (309), *O. eversa* (310).

——— Contributions to the Tertiary geology and paleontology of the United States.

Philadelphia, 1884, 4to, 117 pp. and map.

In this volume the author gives a full discussion of the Eocene deposits of Delaware, Maryland and Virginia.

——— The Tertiary Geology of the Eastern and Southern United States.

Jour. Acad. Nat. Sci., Phila., 2nd ser., vol. ix, 1884, pp. 115-154, map.

A monographic study of the formations and a correlation of the different areas among themselves and with those of Europe. Description of Eocene and Miocene formations of Maryland.

——— On some new species of Eocene Mollusca from the southern United States.

U. S. Nat. Mus. Proc., vol. iii, 1886, pp. 149-152 and plate.

This article contains a description of *Crassatella declivis*.

——— Explorations on the West Coast of Florida.

Trans. Wagner Free Inst. Sci., vol. i, 1887.

The relation of the Maryland Eocene to that of New Jersey, Alabama, Mississippi and of Europe is briefly indicated (p. 127).

Heinrich, O. J. The Mesozoic formation in Virginia.

Trans. Am. Inst. Min. Engs., vol. vi, 1878, pp. 227-274.

The relations of the Eocene to Mesozoic strata are indicated.

Higgins, James. Reports of the State agricultural chemist of Maryland for 1850, 1852, 1853, 1854, 1856, and 1858.

These reports contain brief references to the Eocene deposits, chiefly of an economic character.

Hotchkiss, Jed. Virginia: a geographical and political summary, embracing a description of the State, its geology, soils, minerals, climate, etc.

Richmond, 1876, 8vo, pp. iv, 319, and 4 maps.

The book contains a description of the Eocene deposits of Virginia, based largely on the earlier observations of Rogers.

Kalm, Peter. En Resa til Norra America. Stockholm, 1753-1761, 8°, 3 vols., with English, German, and French translations.

This work contains the earliest recorded observations on the geology of the Coastal Plain.

LEA, HENRY C. Catalogue of the Tertiary Testacea of the United States.

Proc. Acad. Nat. Sci. Phila., vol. iv, 1848, pp. 95-107.

The author includes in his list the names of the Eocene fossils from the Middle Atlantic Slope.

LEA, ISAAC. Contributions to geology.

Philadelphia, 1833, 8vo, 227 pp. and 6 plates.

The Fort Washington deposits are correlated by the author with those of Claiborne, Ala., and a description is given of many forms from the latter locality, some of which have since been found in Maryland.

LYELL, CHARLES. On the Tertiary formations and their connection with the chalk in Virginia and other parts of the United States.

Proc. Geol. Soc., London, vol. iii, 1842, pp. 735-742.

The article contains a description of the James River Eocene deposits, and the importance of *Venericardia planicosta* as a type fossil is discussed.

——— On the Miocene Tertiary strata of Maryland, Virginia, and North and South Carolina.

Proc. Geol. Soc., London, vol. iv, 1845, pp. 547-563; Quart. Jour. Geol. Soc., London, vol. i, 1845, pp. 413-429.

The author refers to the Eocene in several of the sections that are given.

——— Observations on the white limestone and other Eocene or older Tertiary formations of Virginia, South Carolina, and Georgia.

Proc. Geol. Soc., London, vol. iv, 1845, pp. 563-576; Quart. Jour. Geol. Soc., London, vol. i, 1845, pp. 429-442.

The author gives a description of the Eocene deposits of the James River, as well as of the Richmond and Petersburg areas. The occurrence of *Venericardia planicosta* and of a form similar to *Ostrea bellovacina* of Europe is mentioned.

MACLURE, W. Observations on the geology of the United States, explanatory of a geological map.

Trans. Amer. Philos. Soc., old series, vol. vi, 1809, pp. 411-428.

——— Observations on the geology of the United States of North America, etc.

Ibid., new series, vol. i, 1817, pp. 1-92.

——— Observations on the geology of the United States of America.

Philadelphia, 1817, 8vo, 130 pp.

In the publications of Maclure the entire Coastal Plain is referred to the "alluvial formation." A translation of the first article above mentioned appeared in the Journal de Physique, vol. lxix, 1809, pp. 204-213, and vol. lxxii, 1811, pp. 137-165, and of the second article in Leonard's Zeitschrift, Band I, 1826, pp. 124-138.

MAURY, M. F. Physical survey of Virginia. Richmond, i, 1868, 8°, 90 pp.; ii, 1878, 8°, 142 pp.

This publication contains several references to the stratigraphical relations of the Eocene.

McGee, W J Three formations of the Middle Atlantic Slope.

Amer. Jour. Sci., 3rd ser., vol. xxxv, 1888, pp. 120-143, 328-330, 367-388, 448-466.

The author discusses the general features of Coastal Plain stratigraphy, and refers to the contact of the Eocene and Potomac in Virginia.

——— Map of the United States exhibiting the present status of knowledge relating to the areal distribution of geologic groups.

Fifth Ann. Rept. U. S. Geol. Survey, 1885, pp. 36-38, map as pl. ii.

This map, compiled from various sources, shows on a small scale the distribution of the Eocene deposits in the Middle Atlantic Slope.

——— The Lafayette formation.

Twelfth Ann. Rept. U. S. Geol. Survey, 1892, pp. 347-521, pls. xxxii-xli.

The Eocene deposits of the Middle Atlantic Slope are described and the physical history of the formation is pointed out.

——— Geology of Washington and Vicinity.

Guide to Washington and its Scientific Institutions, 1891, pp. 38-64; and Congres Géologique International. Compte Rendu, 5me Session, Washington 1891, pp. 219-251, 1893.

Article prepared with the collaboration of G. H. Williams, N. H. Darton and Bailey Willis. Contains description of the Eocene by Darton.

Miller, S. A. North American Mesozoic and Cenozoic geology and paleontology.

Cincinnati, 1881, 8vo, 338 pp.

Brief general statements regarding the Eocene deposits of the Middle Atlantic Slope are made by the author.

Morton, S. G. Geological observations on the Secondary, Tertiary, and Alluvial formations of the Atlantic Coast of the United States of America. Arranged from the notes of Lardner Vanuxem.

Jour. Acad. Nat. Sci., Phila., vol. vi, 1829, pp. 59-71.

The attempt is made by the author, in a general way, to delimit more accurately the several formations of the Atlantic Coastal Plain, although at that time the Eocene was not differentiated.

——— Synopsis of the organic remains of the Cretaceous group of the United States. Appendix: Catalogue of the fossil shells of the Tertiary formations of the United States.

Philadelphia, 8vo, 1834, 88, 8 pp.

(Abst.) Amer. Jour. Sci., vol. xvii, 1835, pp. 377-381.

The author gives in his catalogue the Atlantic Tertiary species which had been up to that time described.

——— Additional Observations [to Synopsis].

Philadelphia, 8vo, 1835, 4 pp.

The author adds *Gryphaea vomer* to the Eocene forms from Upper Marlboro and Piscataway.

Murchison, R. I. Secondary and Tertiary rocks and superficial deposits of North America.

Proc. Geol. Soc., London, vol. iv, 1843, pp. 127-133.

The author reviews the results of Lyell's investigations upon the Tertiary strata of America, adding his own interpretation of some points.

Nickles, John M., and Bassler, Ray S. A Synopsis of American Fossil Bryozoa.

Bull. 173, U. S. Geol. Survey, 1900, p. 72.

Upper Marlboro is included in the list of Eocene localities.

Pierce, J. Practical remarks on the shell-marl region of the eastern parts of Virginia and Maryland, and upon the bituminous coal formation in Virginia and the contiguous region.

Amer. Jour. Sci., vol. ii, 1826, pp. 54-59.

Reference is made to the localities at Upper Marlboro, and Potomac Creek.

Rogers, W. B. On the discovery of greensand in the calcareous deposits of eastern Virginia, and on the probable existence of this substance in extensive beds near the western limits of our ordinary marl.

Farmer's Register, vol. ii, 1834. Reprinted in the Geology of the Virginias, 1884, pp. 3-9.

The author refers in a general way to the greensand deposits of eastern Virginia, which he compares with similar beds in New Jersey.

——— Further observations on the greensand and calcareous marl of Virginia.

Farmer's Register, May, 1835. Reprinted in Geology of the Virginias, 1884, pp. 11-20.

In this publication the author makes the first announcement of the occurrence of the Eocene in Virginia.

——— Report of the geological reconnoissance of the State of Virginia, made under the appointment of the Board of Public Works, 1835. Richmond, 1836, 4°, 52 pp. and plate.

Reprinted, Phila., 1836, 8vo, 143 pp. and plate, and in Geology of the Virginias, 1884, pp. 21-122.

This report contains a general statement regarding the "Eocene Marl District" of eastern Virginia, with a description of the lithologic character of the strata in the different river valleys.

——— Report of the progress of the geological survey of the State of Virginia for 1836. Richmond, 1837, 4°, 14 pp.

Reprinted, Phila., 1838, 8vo, and in Geology of the Virginias, 1884, pp. 123-145.

The Eocene deposits of the peninsula between the Potomac and Rappahannock rivers are described by the author.

——— Report of the progress of the geological survey of the State of Virginia for 1837. Richmond, 1838, 4°, 24 pp.

Reprinted, Phila., 1838, 8vo, and in Geology of the Virginias, 1884, pp. 147-188.

Brief mention is made of the Eocene deposits on the James River.

——— Report of the progress of the geological survey of the State of Virginia for 1839. Richmond, 1840, 8°, 161 pp.

Reprinted in Geology of the Virginias, 1884, pp. 245-410.

In this report the author describes in much detail the "Tertiary Marl region south of the James River."

——— Report of the progress of the geological survey of the State of Virginia for 1840. Richmond, 1841, 8°, 132 pp.

Reprinted in Geology of the Virginias, 1884, pp. 411-535.

This report contains a description of the "Tertiary Marl region between the Potomac and the Rappahannock rivers," and also of the "Tertiary beds in the vicinity of Richmond."

——— Infusorial deposit of Virginia in the Fort Monroe artesian well.

The Virginias, vol. iii, 1882, pp. 151-152. Reprinted in Geology of the Virginias, 1884, pp. 733-736.

The character of the Eocene strata penetrated in the well-boring is given at various depths.

Rogers, W. B. and H. D. Contributions to the geology of the Tertiary formations of Virginia.

Trans. Amer. Philos. Soc., new series, vol. v, 1837, pp. 319-341; vol. vi, 1839, pp. 347-370, 371-377, pls. 26-30. Reprinted in Geology of the Virginias, 1884, pp. 659-673, pls. i-v.

The authors describe *Nucula cultelliformis*, *N. parva*, and *Cytherea ovata* from Coggins Point, James River, *Ostrea sinuosa* from Evergreen, James River, *Cucullaea transversa* and *Venericardia ascia* from King George County, *Cucullaea onochela* and *Crassatella capri-cranium* from the peninsula between the Potomac and Rappahannock rivers, and *Cytherea lenticularis* from "eastern Virginia."

——— The same [abstract].

Proc. Amer. Philos. Soc., vol. i, 1839, pp. 88-90.

Ruffin, Edmund. Description of a nut found in Eocene marl.

Amer. Jour. Sci., 2nd series, vol. ix, 1850, pp. 127-129.

The author describes a nut found in the Eocene marl of the Pamunkey River, Virginia.

Say, Thomas. An account of some of the fossil shells of Maryland.

Jour. Acad. Nat. Sci., Philadelphia, vol. iv, 1828, pp. 124-155, pls. 7-13.

In this article *Ostrea compressirostra* is described, but no locality is given.

Schöpf, J. D. Beyträge zur mineralogischen Kenntniss des östlichen Theils von Nordamerica und seiner Gebürge. Erlanger, 8°, 1787, 194 pp.

The author gives the result of his observations in the eastern United States, referring to some of the more striking features of the Atlantic Coastal Plain.

TUOMEY, M. Discovery of a chambered univalve fossil in the Eocene Tertiary of James River, Virginia.

Amer. Jour. Sci., vol. xliii, 1842, p. 187.

This article contains some conclusions of the author regarding the stratigraphy of the Eocene, based on a section exposed in a shaft sunk at Evergreen on the James River.

TYSON, PHILIP T. First report of Philip T. Tyson, State agricultural chemist, to the House of Delegates of Maryland, January, 1860.

Annapolis, 1860, 8vo, xi, 145, and 20 pp. and one map.

The author describes the Tertiary formations collectively, stating that the work has not progressed far enough to separate the different divisions, although he refers to the Eocene greensand marl.

——— New topographical atlas of the State of Maryland, etc. 1873.

This work contains a general statement regarding the geology of Maryland, including a description of the Eocene.

UHLER, P. R. Observations on the Eocene Tertiary and its Cretaceous associates in the State of Maryland.

Trans. Maryland Acad. Sci., vol. i, 1888, pp. 10-32.

——— Additions to observations on the Cretaceous and Eocene formations of Maryland.

Trans. Maryland Acad. Sci., vol. i, 1889-1890, pp. 45-72.

——— Notes and illustrations to "Observations on the Cretaceous and Eocene formations of Maryland."

Trans. Maryland Acad. Sci., vol. i, 1890, pp. 97-104.

The above articles contain an extensive description of the Eocene and a discussion of its relations to the Cretaceous.

VAN RENSSELAER, J. Lectures on geology, New York, 8°, 1825, 350 pp.

The author accepts the conclusions of Finch regarding the so-called "Alluvial formation," and describes briefly the Tertiary formations of the Northern Atlantic Coastal Plain.

VAUGHAN, T. WAYLAND. Contributions to the Eocene Fauna of the Middle Atlantic Slope. Coelenterata.

Johns Hopkins Univ. Circ., 1895, vol. xv, p. 6.

The author describes *Paracyathus* (?) *clarkeanus* and *Turbinolia acuticostata* from Potomac Creek.

——— The Eocene Deposits in the Middle Atlantic Slope in Delaware, Maryland and Virginia. Coelenterata.

Bull. 141, U. S. Geol. Survey, 1896, pp. 89-91.

The same forms are described as in the above article.

——— Eocene and Lower Oligocene Corals of the United States.

Monograph U. S. Geol. Survey, No. xxxix, Washington, 1900.

The author describes in much detail the coral species from Maryland and Virginia.

General Stratigraphic Relations.

Our knowledge of the Tertiary geology and paleontology of the Middle Atlantic Slope has been largely increased since the days of Conrad and Rogers, yet few fields have afforded better opportunities in recent years for continued investigation, since very divergent opinions have prevailed and even to-day find expression in the different interpretations of the data.

Both the Eocene and the Neocene divisions of the Tertiary in this area have broad surface exposures, and are represented by characteristic sections along the leading waterways. Both are also highly fossiliferous, although the Neocene shows a greater diversity of species than does the Eocene. This difference, however, is not so great as one would infer from a perusal of the literature, since a large number of Eocene species, many of them very common, have been until recently unrecognized, or at least unrecorded.

A brief discussion of the general relations of the Coastal Plain deposits in the Middle Atlantic Slope is essential to a clear comprehension of the Eocene formations. A more detailed history of the several groups of deposits will be found in other volumes of the Survey.

The Coastal Plain consists geologically of a series of formations that were deposited as moderately thin sheets, one above another, along the eastern border of the crystalline belt, elsewhere referred to as the Piedmont Plateau. The coastal deposits are slightly inclined eastward, so that successively later members of the series are encountered in passing from the interior of the country toward the coast.

From the beginning of deposition in the coastal region until the present time sedimentation has apparently been constantly in progress over some portions of the area. Differential movements of the sea-floor, with its accumulated sediments, took place, however, from time to time, so that the formations present much complexity along their western margins. It is not uncommon there to find certain members of the series lacking, as renewed deposition carried a later formation beyond its predecessors. In the absence of distinctive fossils, the discrimination of the different horizons at such points is often attended with great uncertainty.

FIG. 1.—FARM- AND WOOD-LAND ALONG SOUTH RIVER.

FIG. 2.—FARM-LAND NEAR ANNAPOLIS WATER WORKS.

VIEWS OF SURFACE OF EOCENE COUNTRY.

Deformation has also affected the region to a limited extent, the strata being slightly warped, so that the plane of bedding does not maintain a uniform strike and dip. This is particularly marked along the western border of the area. There have also been slight displacements in various localities. McGee[1] has described one of these, while others have been observed by the junior author of this report.

It seems highly probable that every geological period from the Cretaceous (possibly Upper Jurassic) to the Pleistocene is represented, although in one or two instances the lack of characteristic fossils renders the taxonomic position of certain formations difficult of absolute determination.

CRETACEOUS.

The Cretaceous (in part possibly Upper Jurassic) is extensively represented in the Middle Atlantic Slope. The deposits of this period consist of a series of basal formations that has been designated the Potomac group, comprising the Patuxent, Arundel, Patapsco and Raritan formations, none of which was deposited under marine conditions, overlain in succession by the Matawan, Monmouth, and Rancocas formations, which are distinctly marine in origin. All but the Potomac formations gradually disappear southward, that group alone of the Cretaceous deposits being recognized in Virginia. Unconformities characterize the several members of the Potomac group while the marine deposits are also unconformable to the older strata.

The Potomac group consists chiefly of sands and clays, the former frequently arkosic, with gravel at certain points where the shore accumulations are still preserved. The deposits of the Patuxent formation are highly arkosic, the sands and clays showing both a vertical and a horizontal gradation into one another. The sand layers are seldom widely extended, being generally lenticular masses, which rapidly diminish in thickness from their centers. Dark colored clays abound in the Arundel formation and have yielded large amounts of nodular carbonate of iron. Highly colored and variegated clays largely make up the Patapsco formation. Thick-bedded and widely extended white sands

[1] 7th Ann. Rept., U. S. Geol. Survey, pp. 616-633.

with interstratified clays characterize the Raritan formation. The fossils consist chiefly of the bones of dinosaurian reptiles and of leaf impressions, the former confined to the Arundel formation, the latter predominating in the Patapsco and Raritan formations. The plants show beyond a doubt the Cretaceous age of the two upper formations while the reptiles have been regarded by high authority to be upper Jurassic.

The Matawan formation is formed largely of fine sands and clays, clearly stratified, and in the case of the clays often laminated. The clays and sandy clays are generally dark, often black, in color. They are commonly micaceous, and at time sparingly glauconitic. The very homogeneous and persistent character of the beds is in marked contrast to the deposits of the Potomac group which they overlie. The fossils consist largely of marine Mollusca which indicate the upper Cretaceous age of the deposits.

The Monmouth formation consists chiefly of greensand deposits, although the glauconitic element is not so pronounced or so persistent south of the Chesapeake as in the more northern districts. The strata are more arenaceous, and as a result the materials weather more readily, showing generally in greater or less degree the characteristic reddish color of the hydrated peroxide of iron. The common and characteristic *Gryphaea vesicularis*, *Exogyra costata*, and *Belemnitella americana* are widely found, with other typical forms.

The Rancocas formation is also largely composed of greensands, generally more glauconitic than the Monmouth formation, although at times somewhat argillaceous. The strata are much weathered where exposed, and often appear as a firm red rock, the grains being cemented by the iron oxide. The deposits have afforded *Terebratula harlani*, *Gryphaea bryani*, and other characteristic species of the New Jersey area.

EOCENE.

The Eocene is represented in the Middle Atlantic Slope by a group of deposits stretching along the eastern margin of the Coastal Plain and overlying the Cretaceous formations unconformably. They will be described in much detail in the following pages.

The deposits consist largely of greensand marls, which may, how-

ever, by weathering, lose their characteristic green color, and by the deposition of a greater or less amount of hydrous iron oxide become firm red or brown sandstones or incoherent red sands. At times, notably in Southern Maryland and Virginia, the strata become highly argillaceous, the glauconitic elements largely or quite disappearing. Infrequently coarse sands and even gravels are found, the latter chiefly toward the base of the formation and near the ancient shore line, especially toward the northeast in central and eastern Maryland.

Very commonly the shells of organisms are so numerous as to form the chief constituent of certain beds. Notwithstanding these facts, the deposits are remarkably homogeneous, although recent investigations have shown the possibility of dividing the deposits into two well-marked formations on both lithologic and faunal grounds. The lower or Aquia formation is much more highly arenaceous than the upper or Nanjemoy formation which, particularly in its lower part, is generally highly argillaceous. The Aquia formation is also much more calcareous than the Nanjemoy formation, indurated layers frequently appearing in the former.

NEOCENE.

The Neocene deposits occupy the region to the southeast of and overlie the Eocene. The lower beds comprise the Chesapeake group, so named from the superb sections found exposed on the shores of Chesapeake Bay, and recognized to consist of three well-defined formations; the upper beds comprise the Lafayette formation. The Neocene deposits lie unconformably upon those of the Eocene and overlap them along their western border, where they ultimately come to rest upon the Cretaceous toward the northeast. They are in turn unconformably overlain by the Pleistocene deposits.

The Chesapeake group consists of sands, clays, marls, and diatomaceous beds. The latter, composed almost exclusively of the tests of diatoms, are chiefly confined to the lower portion of the basal formation, where they afford striking, light-colored bluffs along many of the larger stream channels. The nearly pure diatomaceous earth reaches a thickness of 30 or 40 feet, although the remains of diatoms are found scattered in greater or less amounts throughout much of the overlying strata.

The greater portion of the Chesapeake, however, is composed of variously colored sands and clays, with which are frequently mingled vast numbers of molluscan shells. Sometimes the shelly materials form so large a proportion of the deposits as to produce nearly pure calcareous strata, which in a partially comminuted state may become cemented into hard limestone ledges. The organic remains are very numerous and show the Neocene age of the deposits. Their great number early attracted the attention of geologists, in whose writings descriptions of them are frequently found. Several faunas have been distinguished on the basis of which, as well as on stratigraphic and structural grounds, a number of well-defined formations have been recognized by the State Geological Survey.

Covering the Chesapeake deposits in places, is a formation composed of gravel, sand, and clay, which thus far has afforded no distinctive fossils upon which to base a determination of its geologic age. From the fact that the deposits rest unconformably upon the underlying Chesapeake, and are in turn unconformably overlain by the Pleistocene, they have been thought to represent the late Neocene or Pliocene. The apparent similarity of these deposits to those in Mississippi, described by Hilgard under the name of the Lafayette formation, has led to the adoption of the same name for the strata of the Atlantic Coast. The beds of the Lafayette are very irregularly stratified, and often change rapidly within narrow limits. Toward the ancient shore-line the deposits are of coarse gravel, through which is scattered a light-colored sandy loam, the whole cemented at times by hydrous iron oxide into a more or less compact conglomerate. The eastward extension of the formation shows a gradual lessening of the coarser elements and a larger admixture of loam. Arkosic materials are also present throughout the formation, while the coloring and manner of weathering are highly characteristic, the exposed surfaces presenting what is known as case-hardening.

PLEISTOCENE.

Superficially overlying the deposits hitherto described, and with marked variations in thickness, composition, and structure, is the Pleistocene, which lies at various elevations from near sea-level to 200 feet

FIG. 1.—ZONES 2 TO 6 AT MOUTH OF AQUIA CREEK.

FIG. 2.—BLOCKS OF ZONE 9, LARGELY COMPOSED OF *TURRITELLA MORTONI.*

VIEWS OF EOCENE SECTIONS.

in the different portions of the region. From its typical development in the District of Columbia all the Pleistocene deposits of the Middle Atlantic Slope received the name of Columbia formation by McGee who described three distinct phases, viz., the fluvial, the interfluvial, and the low-level. Later Darton recognized high-level and low-level phases which he called earlier and later Columbia. More recently Shattuck, of the State Geological Survey, has shown that greater complexity exists in the Maryland Pleistocene deposits than had been before recognized, and that the later Columbia will have to be further divided, at least locally. The Pleistocene deposits consist of gravel, sand, clay and loam, the materials in general becoming finer and more fully stratified with distance from the old shore-line and river-channels. In the latter instance they at times contain large numbers of marine molluscan shells, forming a characteristic calcareous marl. In general, however, the organic remains consist largely of the branches and leaves of terrestrial plants, many of which are exquisitely preserved.

Distribution of the Strata.

The Eocene strata of the Middle Atlantic Slope form a belt of varying width, extending from northeast to southwest, somewhat to the west of the center of the Coastal Plain. This belt has been traced almost continuously from the southern portion of Newcastle county, Delaware, to the valley of the Nottoway river, in southern Virginia. Although at times buried beneath later deposits, the Eocene presents fine exposures along all the leading stream-channels, while not infrequently broad outcrops of the formation appear at the surface in the intervening country.

DELAWARE.

In Delaware the Eocene is found apparently only near the Maryland line and slightly to the south of the central portion of Newcastle county, where it occupies a restricted portion of the country between Appoquinimink Creek on the north and Old Duck Creek on the south. Toward Delaware Bay the formation entirely disappears, the Neocene resting directly upon the Cretaceous. Even in the limited area where found

the Neocene deposits widely cover the Eocene, so that in the absence of large streams satisfactory exposures of the strata are not found.

MARYLAND.

In eastern Maryland the conditions of outcrop become more favorable, although the Neocene deposits still cover the higher portions of the country while the Pleistocene beds often fill the valleys and cover the lowlands adjacent to the Bay. Several fine sections are found in the drainage basin of the Chester river in both Kent and Queen Anne's counties, the width of outcropping beds broadening from a few miles at the boundary to more than 10 miles in some places, and reaching quite to the valley of the Sassafras river. On the western side of the Chesapeake the Eocene is much more extensively developed than upon the eastern, and covers wide areas in Anne Arundel, Prince George's, and Charles counties.

In Anne Arundel county the best sections are found along the Severn and South rivers and their tributaries. The highland forming the neck below the lower Magothy and Severn rivers is largely composed of Eocene beds, the most western exposure being found at Mount Misery, near Round Bay, Severn river, at an altitude of 100 feet, while eastward it reaches to water-level. The higher portions of the area between the Severn and South rivers are also largely made up of Eocene deposits, as is also the land to the southwest of the latter stream and between it and the valley of the Patuxent river. Throughout the southern portion of the county the Eocene is, however, capped by the Neocene and Pleistocene formations along the central highland.

Much of the western-central portion of Prince George's county is composed of Eocene strata, many fine sections occurring along the western branches of the Patuxent river. Along the Potomac the strata are found in numerous bold bluffs, while broad exposures appear in the valleys of many of the larger tributaries, notably in Piscataway and Mattawoman creeks. Upper Marlboro, on the eastern side, and Fort Washington on the western side of the county are among the best known localities for Eocene fossils in the Middle Atlantic Slope.

In Charles county the Eocene is confined to its western half, fine sec-

tions being found at Clifton Beach, along Port Tobacco River, and at Popes Creek. Since the deposits are in general at lower levels than in Prince George's county, on account of the easterly dip of the beds, the surface outcrops are largely covered by the Neocene and Pleistocene formations.

VIRGINIA.

The most complete section of the Eocene in the whole Middle Atlantic Slope is afforded by the series of high bluffs on the western bank of the Potomac river between Aquia Creek and Mathias Point, in eastern Stafford and northern King George counties. The peninsula between the Potomac and Rappahannock rivers is to a large extent formed of the Eocene greensands, which also appear in places along the banks of the latter stream, outcropping beneath the Columbia formations. The higher levels of the intervening country are generally capped by the Neocene formations.

Southward the Eocene deposits are continued in eastern Spottsylvania and in Caroline counties. Fine bluffs of the characteristic marls appear on the south bank of the Rappahannock at several points above Port Royal, but in the valley of the Mattapony they are much less prominent, although occurring at frequent intervals. An extensive cover of Neocene deposits occupies the higher portions of the country.

In the valley of Pamunkey river and its tributaries, particularly in Hanover county, important outcrops of the Eocene are found. Many of the fossils described by Conrad and Rogers were obtained from this area.

Farther south, in the valley of the James river, are many of the most notable occurrences of the Eocene in the whole region. At Richmond, City Point, Evergreen, and Tar Bay prominent exposures are found, the two latter localities particularly being rich in organic remains. At Petersburg and vicinity the Eocene is exposed in the valley of the Appomattox, but the sections are in the main poor. South of Petersburg the only exposure so far as known is at Bolling's Bridge, on the Nottoway river.

General Character of the Deposits.

COMPOSITION.

The Eocene deposits of the Middle Atlantic Slope are typically glauconitic, and are found in their unweathered state either as dark gray or green sands or clays. The glauconite varies in amount from very nearly pure beds of that substance to deposits in which the arenaceous and argillaceous elements predominate, although the strata are generally very homogeneous through considerable thicknesses. At certain horizons the shells of organisms are found commingled with the glauconitic materials in such numbers as largely to make up the beds, producing what is known as a greensand marl. These beds are at times so indurated as to form true limestone ledges. This latter phase is seen typically developed both at Fort Washington and Aquia Creek, interstratified with the unconsolidated greensand layers.

When the glauconite is weathered the deposits lose their characteristic gray or green color and generally become lighter gray with reddish or reddish-brown streaks or bands, or may be entirely of the latter color. This change to red beds particularly characterizes the Eocene deposits of the northern portion of the area, from the Patuxent valley to the Delaware line. Throughout much of this territory the beds are coarse sands and become predominently so toward the northeast. This type of material is well seen on Mount Misery on the north bank of the Severn river and at various points on the Chester river, where it is often cemented into a ferruginous sandstone. In the less completely weathered portions of the formation farther south the change is indicated by the mottled yellow and brown appearance of the more superficial beds, many of the glauconitic grains still showing their green color when crushed. Thin iron crusts at times appear in strata of this character.

It is noteworthy that in the northern portion of the area the cementing medium of the indurated beds is either ferruginous or siliceous while in the southern portion it is chiefly calcareous.

When the glauconite is largely or, more rarely, entirely absent in the original materials, the deposits consist of black or gray sands or clays, the latter at times micaceous, and in a few instances carbonaceous.

A microscopical examination of several selected specimens from dif-

ferent portions of the area shows that the land-derived elements of the deposits are mainly quartzose, quartz grains predominating. Fragments of crystalline rocks occur, while numerous constituent and accessory minerals derived from them are found.

Chemical analyses of several typical specimens, made by Mr. Peter Fireman, of Columbian University, give the following results:

ANALYSES OF MARLS.

	Nanjemoy.	Aquia.	
	I. Woodstock.	II. Aquia Creek.	III. Winchester.
SiO_2	60.87	21.58	49.08
$Al_2O_3 + Fe_2O_3$ *a*	22.68	7.70	41.25
MgO	2.77	1.05	.76
CaO	1.66	36.78	None.
Na_2O	.23	.59	.42
K_2O	.77	.37	.39
H_2O at 110°	3.58	0.76	1.31
CO_2	3.17	29.79	.55
Volatile at red heat less CO_2	2.84	.21	6.27
P_2O_5	None.	.09	.13
	98.57	98.92	100.16
Siliceous matter	73.48	25.36	52.30

a Considerable Fe_2O_3 in all samples.

STRIKE AND DIP.

The strike of the Eocene deposits in Delaware and Maryland is approximately northeast and southwest, while in Virginia the prevailing trend is more nearly north and south. This change in direction of strike takes place in the area between the Patuxent and Rappahannock rivers, chiefly in the Potomac basin.

Careful measurements made at each of the local sections show the dip of the strata to be on the average about 12½ feet to the mile. The Turritella bed (Zone 9), which has an elevation of 62 feet at its base in the Aquia Creek section, has descended to 25 feet in the Potomac Creek section, 3 miles distant, while the indurated layer (Zone 5), which stands at 24 feet at the western end of the Aquia Creek section, has passed below tide level 2 miles to the southeastward. Similar measurements made at Woodstock and in some of the intervening ravines do not change the average estimate of the dip found at the two points first mentioned.

There are some exceptions to this general average, however, and a local dip of 22 feet per mile was observed above Popes Creek.

THICKNESS.

It is evident, therefore, that on this basis of calculation the thickness of the Eocene strata in this area must exceed 200 feet, although it will probably fall short of 300 feet, the amount claimed by Darton.

The results obtained from a study of the various section-lines and well-borings show that the average thickness of the deposits is somewhat more than 200 feet, although estimates based on the Potomac river section, as well as on well-borings in the area to the east of Fredericksburg, show that it somewhat exceeds that amount in this portion of the Middle Atlantic Slope.

The extensive covering of post-Eocene deposits in many portions of the region renders it impossible to obtain data upon which an estimate can be based, and the results of further well-boring will be awaited with interest. From the facts already obtained it seems probable that there is a slight thickening of the beds to the eastward along the line of dip.

Origin of the Materials.

As regards their origin, the chief constituents of the Eocene deposits of the Middle Atlantic Slope may be grouped under three heads, viz.: First, the arenaceous and argillaceous elements, which are land-derived; second, the calcareous elements, which are of organic origin; and third, the glauconitic elements, which are of secondary formation.

The arenaceous and argillaceous materials were undoubtedly originally derived from the crystalline rocks of the Piedmont Plateau, with an indefinite admixture from the Paleozoic formations of the Appalachian region.

The organic remains, which consist very largely of the shells of mollusks, are generally so slightly worn or broken as to justify the belief that they were little disturbed prior to their burial by the sediments in which they are now found entombed. They have, however, lost considerably by solution since they were deposited, the calcareous matter removed serving as a cement to produce the limestone layers found at several horizons in the southern Maryland and northern Virginia area.

The glauconitic elements are secondary in character and were formed *in situ.* Since they enter so largely into the formation of the Eocene greensands, their character and origin will be considered somewhat more fully.

ORIGIN OF GREENSAND.

Great light has been thrown upon this subject by the results of the deep-sea dredgings which have been made in recent years by the vessels sent out on scientific expeditions under government auspices. The most important of these expeditions was that of the Challenger, sent out by the British Government in the years 1872-76. In the report upon the deep-sea deposits, based upon the dredgings of that expedition, Professors Murray and Renard, the authors, present the results of their researches as to the character and distribution of greensand, and at the same time propose a theory to account for the chemical changes which have taken place to produce the mineral glauconite, its chief constituent.

The glauconite occurs both in existing seas and in geological deposits as minute grains, seldom exceeding 1 millimeter in diameter, although these grains may at times become agglomerated into nodules several centimeters in diameter by means of a phosphatic cement. The grains are always more or less rounded, and at times mammillated, with irregular surface outline. They are generally black or dark green in color, but become brighter green upon being crushed. The surface of the grain is sometimes covered with fine punctures, while at other times it is smooth and shining. Some of these glauconite grains are distinct internal casts of foraminifera and of other calcareous shells; but more often they are only indistinct reproductions of the form of the chambers and show no definite connection with the organisms in which they originated. In the Eocene deposits the foraminiferal casts are less distinctly seen than in the deposits of recent seas, yet even here they are not uncommon.

It is estimated that glauconitic deposits cover approximately 1,000,000 square miles of the sea floor, while they are found at nearly all geological horizons from the Cambrian up. On the present ocean floor they are limited to those portions adjacent to the coasts, and for the most part along the higher parts of the continental slopes, where land-

derived materials are deposited in perceptible yet small amounts. The production of glauconite seldom reaches to greater depths than 900 fathoms, and most commonly takes place between 100 and 200 fathoms. The entrance of large rivers into the sea or the prevalence of strong currents bearing sediment tends to interfere with its formation, so that its area of distribution is seldom continuous for great distances.

Although glauconite is not known to be formed except in the presence of land-derived materials, its production is accomplished through the intervention of foraminifera. Their connection with the formation of glauconite was first shown by Ehrenberg[1] in 1855, as the result of a study of greensand from many deposits in Europe and America. Professor Bailey[2] in the succeeding year stated that the formation of greensand is likewise taking place on the floor of existing seas and probably under the same conditions that existed in past geological time.

According to Murray and Renard, the chambers become filled with muddy sediment, and "if we admit that the organic matter inclosed in the shell, and in the mud itself, transforms the iron in the mud into sulphide, which may be oxidized into hydrate, sulphur being at the same time liberated, this sulphur would become oxidized into sulphuric acid, which would decompose the fine clay, setting free colloid silica, alumina being removed in solution; thus we have colloid silica and hydrated oxide of iron in a state most suitable for their combination." The potash which is necessary to complete the composition of glauconite is regarded as derived from the decomposition of the fragments of crystalline rocks or their common constituents, orthoclase and white mica.

Two conditions, then, are requisite for the formation of glauconite: First, the deposition of mineral particles of land-derived origin; and second, the presence of foraminifera. In the absence of either, glauconite will not be produced. On the other hand, it is retarded, and finally ceases altogether, as the amount of deposition of land-derived materials increases adjacent to the coasts. Only, then, within circumscribed limits, which are constantly subject to modification, is the formation of glauconite possible.

[1] Abhandl. K. Akad. Wiss. zu Berlin, 1855, pp. 85–176.

[2] Proc. Boston Soc. Nat. Hist., vol. v, 1856, pp. 364–368.

FIG. 1.—FORT WASHINGTON BLUFF, BASAL EOCENE OVERLYING CRETACEOUS.

FIG. 2.—ZONES 2 TO 4 AT BASE OF AQUIA CREEK BLUFF.

VIEWS OF EOCENE SECTIONS.

Glauconite seldom, if ever, occurs pure in nature, but is mixed with greater or less amounts of arenaceous materials, producing what is known as greensand, a term which is commonly made to embrace the argillaceous deposits as well, particularly when the glauconite grains are visible, although they are more correctly green clays. When the deposits are distinctly calcareous, they are generally known as greensand marls. No definite percentage of any of the constituents is required, and as they are so commonly intermingled the terms just described are used somewhat indiscriminately.

DEPTH OF SEDIMENTATION.

The depth at which sedimentation, as shown by the existing Eocene strata, took place cannot be definitely determined, but the character of both the deposits and the fauna points to seas of moderate depth, probably from 100 to 300 fathoms in the southern portion of the area; while the coarser and less glauconitic materials to the northward suggest even shallower depths. Bagg reports the foraminifera to be mainly of shallow water types while the other classes of organisms are chiefly of the same character.

The glauconitic materials of which the formations are so largely composed show that sedimentation must have been slow, but whether this was due to the fact that the deposition went on far from the shore-line or to the fact that the rivers were draining a surface approaching base-level cannot be satisfactorily determined, although recent work on the physical history of the Appalachian region since the Cretaceous points to the latter explanation as probable.

Stratigraphical and Paleontological Characteristics.

The Eocene deposits of Maryland and adjacent states were described in 1891 by Mr. N. H. Darton[1] of the U. S. Geological Survey under the name of the *Pamunkey formation.* More detailed investigations by the authors of this report indicate that sufficient lithologic and paleontologic differences exist to warrant the establishment of two formational units instead of one. The presence of an argillaceous bed at the base

[1] Bull. Geol. Soc. Amer., vol. ii, 1891, p. 411.

of the upper member has been shown to persist very generally throughout the area, while the beds above and below are sufficiently distinct as regards their lithologic and faunal characteristics to be distinguished readily everywhere by the geologist in the field. It is therefore evident that every interest will be subserved by the establishment of two formations, and they will be thus recognized both in the text and on the accompanying map. Each of these formations also represents a well-defined paleontological stage and each is again divided into two clearly defined members or substages, and the latter again subdivided locally into zones.

FORMATIONS AND FAUNAL STAGES.[1]

The two formational units of the Eocene of Maryland are known as the AQUIA FORMATION and the NANJEMOY FORMATION, names derived from localities in the Potomac valley where the deposits of each division are typically developed. Each is characterized by a well-marked fauna, representing a clearly-defined paleontological stage.[2]

The formations are in each instance divided into two members which represent an equal number of paleontological substages. The AQUIA FORMATION is divided into a basal *Piscataway member* or *substage,* and an overlying *Paspotansa member* or *substage;* and the NANJEMOY FORMATION is divided into a lower *Potapaco member* or *substage* and an upper *Woodstock member* or *substage.*

These various divisions are shown in the following table:

GROUP.	FORMATIONS OR STAGES.	MEMBERS OR SUBSTAGES.
Pamunkey.	Nanjemoy.	Woodstock.
		Potapaco.
	Aquia.	Paspotansa.
		Piscataway.

[1] In discussing the various divisions of the Maryland Eocene deposits a distinction is drawn between stratigraphic and paleontologic units; the former are designated as formations and members, the latter as stages and substages. As their limits are the same the same name is employed for each.

[2] The senior author in an earlier publication (U. S. G. S., Bull. 141, p. 39) divided the Pamunkey on the basis of its contained fauna into the Aquia and Woodstock stages. Later investigation has shown that the fauna from the Woodstock beds constitutes simply a substage, and that this fauna together with the fauna more lately discovered in the underlying beds, and called the Potapaco substage, comprises a larger division now termed the Nanjemoy stage and formation.

Several species have been found which are common to all the substages of the Pamunkey. They are:

Volutilithes petrosus (Conrad).
Calyptraea aperta (Solander).
Cadulus abruptus Meyer and Aldrich.
Corbula oniscus Conrad.
Tellina virginiana Clark.
Modiolus alabamensis Aldrich.

Still other forms are found in both the Aquia and Nanjemoy stages, although not recognized in all the substages. The following species have been found in the Piscataway, Paspotansa, and Potapaco substages, but are not known in the Woodstock, viz.:

Tornatellaea bella Conrad.
Cylichna venusta Clark.
Lunatia marylandica Conrad.
Ostrea (*Gryphaeostrea*) *vomer* (Morton).

The following have been found in the Paspotansa and Potapaco substages, viz.:

Calyptraphorus trinodiferus Conrad.
Dentalium mississippiensis Conrad.

The following form ranges from the Paspotansa through the Potapaco and Woodstock substages, viz.:

Pecten choctavensis Aldrich.

The following forms have been found only in the Piscataway, Paspotansa and Woodstock, viz.:

Myliobatis copeanus Clark.
Odontaspis cuspidata (Agassiz).
Strepsidura subscalarina Heilprin.
Corbula subengonata Dall.
Protocardia lenis Conrad.
Lucina uhleri Clark.
Cucullaea gigantea Conrad.
Nodosaria bacillum Defrance.
Polymorphina gibba d'Orbigny.
Truncatulina ungeriana (d'Orbigny).

The Aquia Formation or Stage.

The Aquia formation, so-called from Aquia Creek, which enters the Potomac river from the Virginia side about fifty miles below Washington, is composed chiefly of greensands and greensand marls, at times highly calcareous and less frequently argillaceous. The various lithological and paleontological characteristics are clearly shown in the detailed sections which follow. The deposits reach about 100 feet in thickness, gradually thickening eastward. The name Aquia was originally employed[1] to embrace the faunal stage represented by Zones 2 to 9.

[1] Johns Hopkins Univ. Circ., 1895, p. 3; Bull. 141, U. S. Geol. Survey, 1896, p. 39.

To these may be temporarily added Zone 1, which, so far as known, is devoid of determinable fossils, although indeterminate molluscan casts and plant remains have been found near the base of the zone. It is possible that this zone should be made an independent stage, and it is not improbable that it may represent a definitely lower Eocene horizon than the more fossiliferous beds which overlie it, but in the absence of distinctive fossils it is impossible to definitely characterize it. It may be regarded at present at least as the basal zone of the Aquia.

The Aquia stage contains an extensive fauna. Among the forms that are found in both substages are the following:

Thecachampsa sp.
Thecachampsa marylandica Clark.
Cythere marylandica Ulrich.
Volutilithes sp.
Caricella pyruloides (Conrad).
Turritella mortoni Conrad.
Turritella humerosa Conrad.
Vermetus sp.
Solarium sp.
Scala virginiana Clark.
Gibbula glandula (Conrad).
Gastrochaena sp.
Panopea elongata Conrad.
Meretrix ovata var. pyga (Conrad).
Lucina aquiana Clark.
Venericardia planicosta var. regia Conrad.
Crassatellites alaeformis Conrad.
Crassatellites aquiana Clark.
Ostrea compressirostra Say
Leda cliftonensis Clark and Martin.
Trochocyathus clarkeanus Vaughan.
Eupsammia elaborata (Conrad).
Nodosaria communis (d'Orbigny).

Other species are restricted to one or the other of the substages and are mentioned beyond. Additional to these are the forms previously referred to as found in both divisions of the Pamunkey group.

The Aquia formation has been divided into two members which are clearly separated by their contained faunas over considerable portions of Maryland and Virginia. They are known respectively as the Piscataway and Paspotansa members or substages.

THE PISCATAWAY MEMBER OR SUBSTAGE.

The Piscataway member, so-called from Piscataway Creek which empties into the Potomac river on the Maryland bank about ten miles below the city of Washington, is characterized by greensands and greensand marls, the lower beds often quite argillaceous. Two well-marked and rather persistent layers of indurated marl characterize the upper beds in the Potomac region. The Piscataway member generally exceeds 50 feet in thickness.

The Piscataway substage is limited to Zones 1 to 7. The fossils restricted to this horizon are:

Thecachampsa sericodon (?) Cope.	*Tudicla* sp.
Thecachampsa contusor Cope.	*Phenacomya petrosa* (Conrad).
Euclastes sp.	*Pholadomya marylandica* Conrad.
Trionyx virginiana Clark.	*Lithophaga marylandica* Clark and Martin.
Synechodus clarkii Eastman.	*Ostrea compressirostra var. alepidota* Dall.
Odontaspis macrota (Agassiz).	*Gryphaea vesicularis* Lamarck.
Odontaspis elegans (Agassiz).	*Terebratula harlani* Morton.
Odotus obliquus (Agassiz).	*Textularia subangulata* d'Orbigny.
Sphyrna prisca Agassiz.	*Vaginulina legumen* (Linné).
Xiphias radiata Clark.	

The various zones of this division in the Potomac region are characterized as follows:

Zone 1.—The thickness of the Eocene deposits beneath the lowest beds holding the typical Aquia fauna has been variously estimated up to 60 feet. Some exposures are seen in the ravines to the west of the bluff, but no complete sequence of the beds has been found. At some points the strata scarcely exceed 10 feet, and at Glymont the beds are only 8 feet in thickness. They, however, gradually increase in thickness seaward. The almost entire absence of fossils renders the faunal relations obscure. The poorly preserved animal and plant remains are of practically no value, and provisionally this bed is left as an indeterminate basal zone of the Aquia. The materials are greensands, frequently quite argillaceous and with a basal pebble bed overlying the Cretaceous at some points.

Zone 2.—This zone is characteristically developed both at the base of the Aquia Creek section and also on the opposite bank of the Potomac river at Glymont. The beds are from 12 to 20 feet in thickness, and entirely disappear below the water-line a little beyond the middle of the Aquia Creek bluff. The dark greensand of which the zone is mainly composed is packed with the shells of *Crassatellites alaeformis* and *Dosiniopsis lenticularis*, while *Turritella mortoni*, *T. humerosa*, *Crassatellites aquiana*, *Meretrix ovata* var. *pyga*, *Cucullaea gigantea*, and *Ostrea compressirostra* also occur.

Zone 3.—The limestone ledge composing this bed is much less persistent than in the overlying limestones, Zone 5, and at times it nearly or quite disappears. It is from 2 to 3 feet in thickness, highly glau-

conitic, and of dark color, and is filled with shells or, more commonly, casts of shells, among which the forms of Zone 2 are conspicuous, together with *Ostrea compressirostra* and *Turritella mortoni* in larger numbers than in the lower beds.

Zone 4.—This zone is composed of a highly typical greensand, containing in the main the forms mentioned above as occurring in zones 2 and 3. It is from 7 to 9 feet in thickness.

Zone 5.—This limestone bed is very persistent and forms a conspicuous ledge about 2 feet in thickness, along the face of the Aquia Creek bluff until it passes below tide-water near its eastern extremity. In addition to the species already mentioned as characteristic for Zones 2 to 4, which still remain common forms, there are two highly typical species, viz.: *Pholadomya marylandica* and *Phenacomya petrosa,* as well as two or three gasteropods, *Tudicla* sp., *Caricella* sp., which from the fact that they have only been found in the form of casts cannot be further identified.

Zone 6.—This thin layer, generally about 1 foot in thickness, of dark characteristic greensand, is packed with the common forms of the previous beds. It thickens somewhat to the eastward along the face of the bluff, and near Marlboro Point contains, among other forms, several species of corals, including *Eupsammia elaborata, Turbinolia acuticostata,* and *Trochocyathus clarkeanus.*

Zone 7.—The bed of greensand overlying the preceding layer is really a continuation of it, although the fossils are few in number and much broken. Fragments of the common forms of previous beds are found. This bed is about 7 feet thick. It is barely possible that this stratum of worn and broken shells represents an unconformity between the Piscataway and Paspotansa members. Of this, however, there is no positive evidence as yet, and we can only call attention to the fact that there are physical indications of more disturbed conditions of sedimentation than are usual in these formations at the very point where the faunal change occurs.

THE PASPOTANSA MEMBER OR SUBSTAGE.

The Paspotansa member, so-called from Paspotansa Creek, which enters the Potomac river from the Virginia bank, a mile below Potomac

Creek, is composed of a thick bed of greensand, overlain by thick-bedded, indurated layers of greensand marl. It is generally somewhat under 50 feet in thickness.

The Paspotansa substage includes Zones 8 and 9. The following fossils are restricted to this substage:

Bythocypris subaequata Ulrich.
Bythocypris parilis Ulrich.
Cytherella marlboroensis Ulrich.
Cytherella submarginata Ulrich.
Cythereis bassleri Ulrich.
Pleurotoma harrisi Clark.
Pleurotoma potomacensis Clark and Martin.
Pleurotoma ducateli Clark and Martin.
Pleurotoma childreni Lea.
Pleurotoma piscatavensis Clark and Martin.
Pleurotoma tysoni Clark and Martin.
Cancellaria graciloides Aldrich *var.*
Cancellaria sp.
Cancellaria potomacensis Clark and Martin.
Mitra marylandica Clark.
Mitra pomonkensis Clark and Martin.
Latirus marylandicus Clark and Martin.
Fusus subtenuis Heilprin.
Trophon sublevis Harris.
Melongena potomacensis Clark and Martin.
Tudicla marylandica Clark and Martin.
Metula marylandica Clark and Martin.
Chrysodomus engonatus (Heilprin).
Pseudoliva sp.
Tritonium showalteri (Conrad).
Fusoficula juvenis (Whitfield).
Morio brevidentata (Aldrich).
Calyptraphorus jacksoni Clark.
Aporrhais potomacensis Clark and Martin.
Litiopa marylandica Clark and Martin.
Scala potomacensis Clark and Martin.
Scala sessilis Conrad.
Scala carinata Lea.
Turbonilla potomacensis Clark and Martin.
Odostomia trapaquara (Harris).
Niso umbilicata (Lea).
Calliostoma sp.
Fissuridea marylandica Clark and Martin.
Diplodonta marlboroensis Clark and Martin.
Crassatellites alta (Conrad).
(?) *Astarte marylandica* Clark.
Coralliophaga bryani Clark.
Pecten sp.
Platidia marylandica Clark and Martin.
Discosparsa varians Ulrich.
Fascipora subramosa Ulrich.
Reticulipora dichomata Gabb and Horn.
Cavaria dumosa Ulrich.
Heteropora tecta Ulrich.
Membranipora rimulata Ulrich.
Membranipora spiculosa Ulrich.
Membranipora angusta Ulrich.
Biflustra torta Gabb and Horn.
Eschara digitata Gabb and Horn.
Lunulites reversa Ulrich.
Cribrilina modesta Ulrich.
Cribrilina crassula Ulrich.
Lepralia subplana Ulrich.
Lepralia labiosa Ulrich.
Mucronella aspera Gabb and Horn.
Paracyathus marylandicus Vaughan.
Balanophyllia desmophyllum Milne-Edwards and Haime.
Textularia gramen d'Orbigny.
Textularia sagittula Defrance.
Nodosaria consorbrina var. emaciata Reuss.
Nodosaria sandbergeri (Reuss).
Nodosaria obliqua (Linné).
Marginula costata (Batsch).
Cristellaria gibba (d'Orbigny).
Cristellaria rotatula (Lamarck).
Polymorphina lactea (Walter and Jacob).
Discorbina turbo (d'Orbigny).
Anomalina ammonoides (Reuss).
Anomalina grosserugosa (Gümbel).

The two zones recognized in the Potomac area are characterized as follows:

Zone 8.—The highly characteristic greensands and greensand marls of the preceding zones are succeeded in the Potomac sections by a zone, some 30 feet in thickness, in which the grains of glauconite have been extensively weathered when exposed, giving the strata, where outcrops are found, a greenish-gray appearance, which changes to a reddish-brown in the upper layers. Several irregular bands packed with *Turritella mortoni* are present in both the Aquia Creek and Potomac Creek sections, while associated with that species at both localities are *Turritella humerosa, Cucullaea gigantea, Crassatellites alaeformis, Ostrea compressirostra*, and many other forms. The upper portions of this bed have afforded most of the species obtained from the Potomac Creek bluff.

Zone 9.—The thick-bedded limestone layers which compose this zone are almost exclusively made up of the shells of *Turritella mortoni*, forming a Turritella rock. (Plate III, Fig. 2.) Between the indurated layers are interstratified layers of unconsolidated and much weathered greensand, which contain few fossils of any description. Great masses of this Turritella rock strew the shore at the base of both the Aquia Creek and Potomac Creek bluffs. The bed is about 10 feet thick in the Aquia Creek bluff, but reaches 17 feet at Potomac Creek. At the latter locality it consists of five feet of limestone at the base, followed by five feet of greensand, two feet of limestone, two feet of greensand, two feet of limestone and one foot of yellowish greensand. The fauna of Zone 9 is evidently identical with that of Zone 8.

The Nanjemoy Formation or Stage.

The Nanjemoy formation, so-called from Nanjemoy Creek, which enters the Potomac river from the Maryland side in Charles county, just below Maryland Point, is composed of greensand, often highly argillaceous, and less frequently calcareous than the lower beds, and with here and there layers containing abundant crystals and crystalline masses of gypsum. The thickness of the deposits is about 125 feet.

The Nanjemoy stage comprises Zones 10 to 17. The following fossils are found in both substages:

Meretrix ovata var. ovata (Rogers).
Lucina dartoni Clark.
Lucina whitei Clark.
Venericardia potapacoensis Clark & Martin.
Ostrea sellaeformis Conrad.
Leda improcera (Conrad).
Leda potomacensis Clark and Martin.
Leda tysoni Clark and Martin.
Nucula potomacensis Clark and Martin.

	THICKNESS IN FEET	ZONE	Member	Formation
Greensand, with *Ostrea sellaeformis*, *Meretrix subimpressa*, *Venericardia potapacoensis*, etc.	80	17	Woodstock Member	Nanjemoy Formation
Greensand, with few fossils, chiefly *Venericardia potapacoensis*,	40	16		
Greenish-grey argillaceous sand with inconstant indurated layer at top and with many typical fossils,	20	15	Potapaco Member	
Greenish-gray argillaceous sand, with bands of gypsum crystals,	8	14		
Light-gray greensand, with *Venericardia potapacoensis*,	8	13		
Greenish-gray argillaceous sand,	8	12		
Indurated argillaceous greensand,	2	11		
Argillaceous greensand with clay bed at base,	26	10		
Interstratified indurated layers and greensands with many *Turritella mortoni*,	17	9	Paspotansa Member	Aquia Formation
Light greenish-gray greensand, with *Turritella mortoni*, *Cucullaea gigantea*, *Crassatellites alaeformis*, *Ostrea compressirostra*, etc.,	80	8		
Greensand, with fragments of shells of lower beds,	7	7	Piscataway Member	
Greensand, with corals,	1	6		
Ind. greensand, with *Pholadomya marylandica*, & *Phenacomya petrosa*,	2	6		
Greensand,	8	4		
Indurated greensand,	3	3		
Dark greensand with many fossils, including *Dosiniopsis lenticularis*, *Meretrix ovata var. pyga*, *Crassatellites alaeformis*, and *Ostrea compressirostra*,	18	2		
Greensand, at times argillaceous,	80	1		

SCALE 40 FEET=1 INCH

GENERAL COLUMNAR SECTION OF EOCENE STRATA IN MARYLAND

Other species are restricted to one or the other of the substages of the Nanjemoy and are mentioned beyond. Additional to these are the forms previously referred to as found in both divisions of the Pamunkey group.

THE POTAPACO MEMBER OR SUBSTAGE.

The Potapaco member, so-called from the early name of Port Tobacco Creek, which is a corruption of the word Potapaco found on the Smith and other early maps, is composed of greensand, often very argillaceous and at times gypseous. The clayey character of the member, especially in the lower bed, is in marked contrast to the more highly glauconitic nature of the Aquia formation. The thickness of the member is about 60 to 65 feet.

The Potapaco substage embraces Zones 10 to 15. The following species are restricted in range to it:

Cypraea smithi Aldrich.
Solen lisbonensis Aldrich.
(?) *Lucina astartiformis* Aldrich.
Periploma sp.
Ceriopora micropora Goldfuss.

The following zones constitute the subdivisions of the Potapaco in the Potomac area, some of which can be recognized over wide areas:

Zone 10.—The greenish-gray sand which overlies the Turritella rock is more argillaceous than the underlying or overlying beds of the Eocene. The glauconite grains have been much weathered and nearly all trace of the shell substance has been removed from the few forms recognized. To the northeast of the Potomac area, throughout the central portion of Southern Maryland, this bed becomes a well-defined clay, as at Upper Marlboro, and has been referred to as the Marlboro clay. The casts found at the Potomac Creek bluff are chiefly those of a *Meretrix*, probably *Meretrix ovata* var. *ovata*. An indurated layer, near the middle of the zone, contains *Calyptraphorus trinodiferus;* below this is the representative of the red clay which occurs typically about Upper Marlboro. No fossils were observed at the Aquia Creek bluff. The bed is about 25 feet in thickness.

Zone 11.—This zone is composed of a thin, indurated layer of argillaceous greensand, 1 to 2 feet in thickness. It is well developed at the Potomac Creek bluff, where it contains *Venericardia potapacoensis*, and is the lowest horizon at which this species has been found.

Zone 12.—A greenish-gray argillaceous sand, containing few unweathered grains of greensand. No fossils have been found in it. The bed is 8 or 9 feet thick.

Zone 13.—This bed consists of a light-gray glauconitic sand, generally somewhat weathered. It is crowded with shells of *Venericardia potapacoensis*, and also contains *Tornatellaea bella*, *Cadulus abruptus*, etc.

It is 3 feet in thickness.

Zone 14.—Overlying the Venericardia layer is a bed of greenish-gray argillaceous sand, some 4 to 6 feet in thickness, that contains a great number of bands filled with gypsum crystals. No fossils were observed.

Zone 15.—This bed consists of greenish-gray argillaceous sand, in which the glauconite grains have often been extensively weathered. The bed has a thickness of 12 to 25 feet.

At various localities in Charles county, notably about Port Tobacco and at the headwaters of Nanjemoy Creek, this zone contains a fauna that is quite distinct from either the Aquia or Woodstock faunas. It is an unweathered greensand, and very argillaceous at these localities. The top of the bed is marked by a well-developed layer of concretions. This layer passes below water-level about 2¼ miles above the mouth of Popes Creek, and is to be seen about six feet above the base of the bluff at Woodstock.

THE WOODSTOCK MEMBER OR SUBSTAGE.

The Woodstock member, so-called from Woodstock, which is an old estate situated a short distance above Mathias Point on the Virginia bank of the Potomac, is characterized by fine, homogeneous greensands and greensand marls, that are less argillaceous than the underlying Potapaco beds. The member has a thickness of 50 to 60 feet.

The Woodstock substage embraces Zones 16 and 17 and contains the following species in addition to those previously mentioned as ranging throughout the Nanjemoy, viz.:

Carcharodon auriculatus (Blainville).
Galeocerdo latidens Agassiz.
Olivula sp.
Levifusus trabeatus (?) Conrad.
Levifusus trabeatus (?) *var.*
Pyrula penita Conrad. *var.*
Pyrula sp.
(?) *Leda parilis* Conrad *var.*
Spiroplecta clarki Bagg.
Nodosaria affinis (d'Orbigny).
Cristellaria radiata Borneman.
Polymorphina austriaca (d'Orbigny).
Polymorphina elegantissima Parker & Jones.
Polymorphina praelonga Terquem.

Turritella potomacensis Clark and Martin.	*Globigerina bulloides* d'Orbigny.
Dentalium minutistriatum Gabb.	*Discorbina bertheloti* (d'Orbigny).
Meretrix lenis (Conrad).	*Pulvinulina schreibersii* (d'Orbigny).
(?) *Meretrix subimpressa* (Conrad).	*Nonionina affinis* Reuss.
(?) *Lucina astartiformis* Aldrich.	*Amphistegina lessonii* d'Orbigny.
Venericardia marylandica Clark & Martin.	*Carpolithus marylandicus* Hollick.
Modiolus marylandicus Clark and Martin.	*Carpolithus marylandicus var. rugosus* Hollick.
Leda parva (Rogers).	

The two zones comprising the Woodstock in the Potomac area are characterized as follows:

Zone 16.—In this zone have been placed the strata intervening between the upper layers of the Potomac Creek section and the base of the Popes Creek section. The deposits are estimated to reach about 40 feet in thickness, and are chiefly greensands and greensand marls. They appear in an unfossiliferous condition in some of the ravines to the west of the Woodstock area, and along the shores where they contain a few fossils of common Woodstock species.

Zone 17.—The highest beds at Woodstock, and the Popes Creek strata, are grouped together in this zone. The materials are very homogeneous, although several inconstant indurated layers appear. The thickness of this zone is about 20 feet. A thin bed of *Ostrea sellaeformis* was observed in the lower part of the zone, although evidently not always at the same horizon. Otherwise, so far as observed, the fossils are the same in the several parts of the two sections. The most common forms are *Protocardia lenis, Glycymeris idoneus, Meretrix subimpressa, Corbula subengonata, Corbula oniscus, Leda cultelliformis, Pecten dalli, Leda improcera, Leda parva, Nucula potomacensis, Lucina dartoni, Lucina uhleri, Lucina whitei,* and *Ringicula dalli.*

LOCAL SECTIONS.

The formations and faunal stages previously described are based on the numerous local sections found scattered throughout the Eocene area of Maryland. The most numerous and complete series of sections is found in the valley of the Potomac river, but other and highly important sections are found to the northward nearly to the Delaware line.

Potomac River Section.

The most complete section of the Eocene deposits of the Middle Atlantic Slope is found in the valley of the Potomac river between Aquia

Creek, Stafford county, Va., and Popes Creek, Charles county, Md. Throughout this distance the bluffs afford a nearly complete sequence of the several beds of the formations, while the fossils are numerous and well-preserved.

The full Potomac Eocene series is given in both generalized and local columnar sections on Plates V and VI. The former is made up chiefly from the local sections afforded by the bluffs at Glymont, Aquia Creek, Potomac Creek, Nanjemoy Creek, Woodstock, and Popes Creek, but contains additional data obtained at a few points inland.

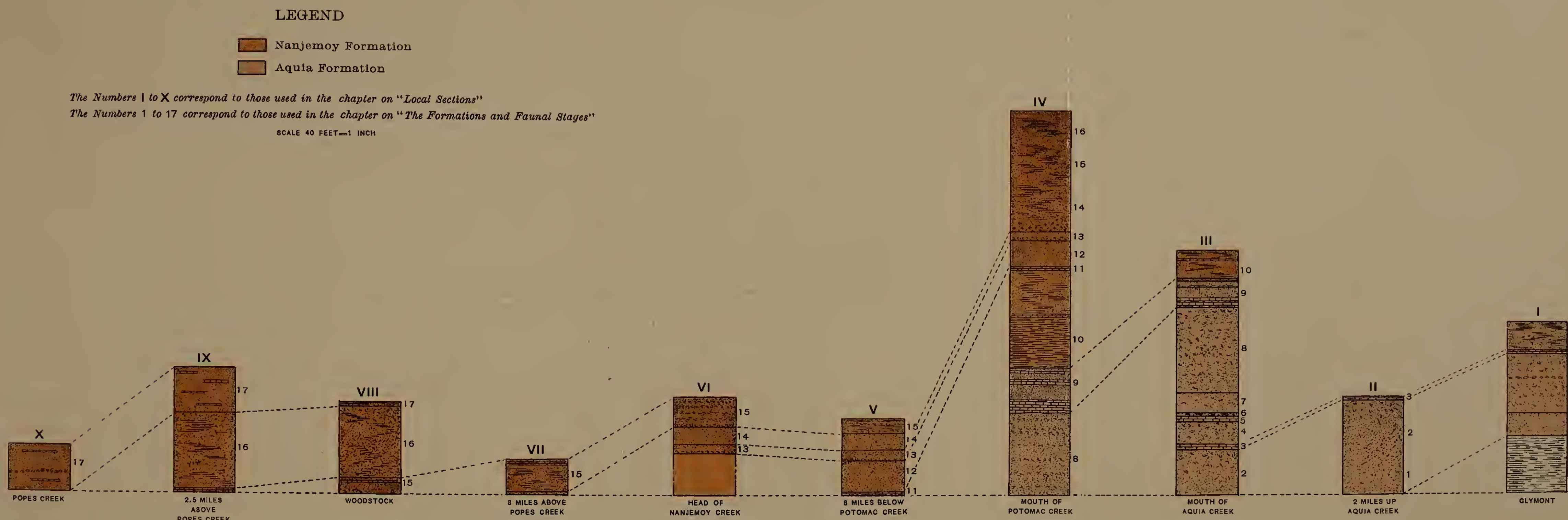
The local sections are presented in columnar form on Plate VI, and the numbering corresponds with that given at the head of the descriptions of the sections which follow. The numbering of the zones in the general section is the same as that in the local sections. The unnumbered zones are pre- or post-Eocene, as the case may be.

I. *Section at Glymont, north of wharf and ravine.*

				Feet.
Pleistocene.			Gravel and loam	20
Eocene.	Aquia.	Piscataway.	Light green glauconitic sand, underlain by argillaceous sand, with few fossils (Zone 4)	10
			Indurated greensand (Zone 3)	1
			Greenish marl with numerous fossils including *Ostrea compressirostra*, *Crassatellites alaeformis*, *Turritella mortoni*, *Dosinopsis lenticularis*, *Meretrix ovata var. pyga*, etc. (Zone 2)	21
			Argillaceous glauconitic sand for the most part without fossils, but containing indeterminate plant remains and molluscan casts at the base (Zone 1)	8
Cretaceous.			Variegated clays of the Potomac group	20
			Total	80

II. *Section two miles up Aquia Creek.*

				Feet.
Pleistocene.			Gravel and sand	7
Eocene.	Aquia.	Piscataway.	Indurated greensand (Zone 3)	1
			Greensand with characteristic fossils (Zone 2)	15
			Argillaceous sand more or less glauconitic without fossils (Zone 1)	18
			Total	41



DETAILED COLUMNAR SECTIONS OF EOCENE STRATA IN THE POTOMAC VALLEY

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III. *Section of western portion of bluff at Aquia Creek.*

				Feet.
Pleistocene.			Fine sand, light-yellow in color, with white clay near the base	26
Eocene.	Aquia.	Paspotansa.	Fine sand, of light-greenish color, containing a few glauconitic grains (Zone 10)	10
			Thick-bedded, arenaceous, and glauconitic limestone interstratified with unconsolidated layers of partially weathered greensand, the indurated layers largely filled with the shells of *Turritella mortoni* (Zone 9)	10
			Fine sand, of gray or green color, containing several irregular bands of *Turritella mortoni*, also *T. humerosa*, *Cucullaea gigantea*, *Crassatellites alaeformis* and *Ostrea compressirostra* (Zone 8)	30
		Piscataway.	Dark-colored greensand, chiefly filled with broken shells of *Meretrix ovata var. pyga* and *Crassatellites alaeformis* (Zone 7)	7
			Ditto, with same shells in whole condition (Zone 6)	1
			Indurated layer of light-colored greensand filled with *Turritella mortoni*, *T. humerosa*, *Crassatellites alaeformis*, *Dosiniopsis lenticularis*, *Meretrix ovata var. pyga*, *Panopea elongata*, *Pholadomya marylandica* (Zone 5)	2
			Greensand marl containing same forms (Zone 4)	8
			Indurated layer of dark-colored greensand with *Crassatellites alaeformis*, *Meretrix ovata var. pyga*, *Dosiniopsis lenticularis*, and *Ostrea compressirostra* (Zone 3)	2
			Greensand marl with *Dosiniopsis lenticularis*, *Meretrix ovata var. pyga* and *Crassatellites alaeformis* (Zone 2)	16
			Total	112

IV. *Section of center of bluff at Potomac Creek.*

				Feet.
Pleistocene.			Fine yellowish sand containing red and brown bands	15
Neocene.			White gritty clay, with Miocene fossils at base	5
Eocene.	Nanjemoy.	Potapaco.	Greenish-gray argillaceous sand, slightly glauconitic (Zone 15)	38
			Argillaceous sand containing bands of selenite crystals (Zone 14)	4
			Light-gray glauconitic sand with *Venericardia potapacoensis* (Zone 13)	3
			Greenish-gray argillaceous sand (Zone 12)	8
			Indurated greensand with *Venericardia potapacoensis* (Zone 11)	1
			Greenish-gray argillaceous sand, glauconitic, with casts of *Meretrix* (Zone 10)	25
	Aquia.	Paspotansa.	Thick-bedded arenaceous and glauconitic limestone interstratified with layers of partially weathered greensand, the indurated strata largely composed of the shells of *Turritella mortoni* (Zone 9)	12
			Greensand bed, much weathered in its upper portions, and filled chiefly with *Turritella mortoni* in several thick layers; also *T. humerosa*, *Cucullaea gigantea*, *Crassatellites alaeformis*, *Ostrea compressirostra*, and many other species (Zone 8)	25
			Total	136

V. *Section three miles below Potomac Creek.*

				Feet.
Pleistocene.			Sand and gravel	2
Eocene.	Nanjemoy.	Potapaco	Greenish-gray argillaceous sand (Zone 15)	4
			Greenish-gray argillaceous sand with gypsum crystals (Zone 14)	5
			Light gray greensand with band containing *Venericardia potapacoensis* (Zone 13)	4
			Greenish-gray argillaceous sand (Zone 12)	10
			Indurated greensand with *Venericardia potapacoensis* (Zone 11)	1
			Total	26

VI. *Section at Head of Nanjemoy Creek.*

				Feet.
Pleistocene.			Sand and gravel	4
Eocene.	Nanjemoy.	Potapaco.	Greenish-gray argillaceous sand with layers containing *Venericardia potapacoensis* (Zone 15)	11
			Light gray greensand with gypsum beds (Zone 14)	6
			Light gray greensand with *Venericardia potapacoensis* (Zone 13)	3
			Covered to tide	75
			Total	99

VII. *Section three miles above Popes Creek.*

				Feet.
Pleistocene.			Gravel and sand	3
Eocene.	Nanjemoy.	Potapaco.	Argillaceous greensand (Zone 15)	6
			Greensand with gypsum crystals (Zone 14)	5
			Total	14

VIII. *Section two and one-quarter miles above Popes Creek.*

				Feet.
Neocene.			Diatomaceous earth	10
Eocene.	Nanjemoy.	Woodstock.	Greensand with fossil casts (Zone 17)	10
			Greensand, somewhat argillaceous (Zone 16)	30
		Potapaco.	Grayish black argillaceous greensand (Zone 15) with numerous bands of *Venericardia potapacoensis* and other fossils, overlaid by a band of concretions	5
			Total	55

IX. *Section of center of bluff at Woodstock.*

				Feet.
Pleistocene.			Yellow and orange-colored sands and gravel	25
Neocene.			Diatomaceous earth with Miocene fossils	5
Eocene.	Nanjemoy.	Woodstock.	Argillaceous greensand (Zone 17)	6
			Dark greensand more or less argillaceous with *Mitra potomacensis*, *Strepsidura subscalarina*, *Turritella potomacensis*, *Mesalia obrata*, *Corbula oniscus*, *Meretrix subimpressa*, *Protocardia lenis*, *Pecten dalli*, *Ostrea sellaeformis*, *Glycymeris idoneus* and *Leda cultelliformis* (Zone 16)	20
		Potapaco.	Greensand with *Tornatellaea bella*, *Cylichna venusta*, *Ringicula dalli*, *Venericardia potapacoensis* and other forms (Zone 15)	6
			Total	62

X. *Section of bluff one mile below Popes Creek.*

				Feet.	Inches.
Neocene.			Diatomaceous earth	40	
Eocene.	Nanjemoy.	Woodstock.	Brown glauconitic clay much oxidized in places	2	
			Band of pinkish-brown clay nodules in glauconitic clay	0	6
			Dark glauconitic clay with many fossil casts	4	
			Concretions with occasional fossils	0	6
			Argillaceous greensand with many casts and occasional shells	3	
			Concretions with many large specimens of *Hercoglossa tuomeyi*	0	6
			Argillaceous greensand with abundant fossils including *Meretrix subimpressa*, *Venericardia potapacoensis*, *Hercoglossa tuomeyi*, *Turritella potomacensis*, *Mesalia obruta*, *Protocardia lenis*, *Modiolus alabamensis*, *Corbula subengonata*, *Mitra potomacensis*, and many other forms (Zone 17)	6	
			Total	56	6

Other Sections.

Along none of the other drainage lines is the sequence of Eocene strata as complete as in the Potomac river area. Several important local sections, composed of one or more members of the series, have been observed at many different points and may be correlated with one or the other of the divisions previously referred to. Some of the more important and typical sections follow.

Section in ravine three-quarters of a mile east of Oxen, Prince George's County.

				Feet.	Inches.
Eocene.	Aquia.	Piscataway.	Yellow glauconitic sand	5	
			Indurated ledge		4
			Black shell marl	4	
			Indurated ledge with *Ostrea compressirostra*		6
			Shell marl, lower part packed with soft shells including *Cucullaea gigantea*, *Ostrea compressirostra*, *Meretrix ovata var. pyga* *Dosiniopsis lenticularis*, *Crassatellites alaeformis*, *Turritella humerosa*	10	
			Total	19	10

Section in Railroad cut near Seat Pleasant, Prince George's County.

				Feet.
Pleistocene.			Gravel and loam	12
Eocene.	Aquia.	Piscataway.	Glauconitic shell marl with *Ostrea compressirostra*	5
			Indurated ledge with *Ostrea compressirostra*, *Modiolus alabamensis*, *Crassatellites alaeformis*, *Corbula* sp., etc	8
			Total	25

Section east of bridge at Upper Marlboro, Prince George's County.

				Feet.
	Nanjemoy.		Glauconitic clay	22
			Pink clay, without glauconite or fossils	22
Eocene.	Aquia.	Paspotansa.	Coarse glauconitic sand	32
			Shell marl with *Gibbula glandula*, *Fissuridea marlboroensis*, *Lucina aquiana*, *Diplodonta marlboroensis*, *Venericardia planicosta var. regia*, *Pteria limula*, *Cucullaea gigantea*, *Leda parilis*, *Nucula ovula*	2
			Indurated ledge with *Turritella mortoni*, *T. humerosa*, *Mesalia obruta*, *Calyptraphorus jacksoni*, *Panopea elongata*, *Meretrix ovata var. pyga Dosiniopsis lenticularis*, *Venericardia planicosta var. regia*, *Crassatellites alaeformis*, *Astarte marylandica*, *Glycymeris idoneus*, *Cucullaea gigantea*, *Leda parilis*, *Nucula ovula*	
			Glauconitic sand full of fine fragments of shells accompanied by bryozoa, echinoid spines and foraminifera; and with *Ostrea compressirostra*, *Gryphaeostrea vomer*, and *Platidia marylandica*. (Known as Bryozoan sand)	5
			Total	88

Section in ravine one mile south of Thrift, Prince George's County.

				Feet.	Inches.
Neocene.			Lead-colored clay with Miocene fossils	40	
Eocene.	Nanjemoy.	Potapaco.	Dark argillaceous greensand	7	
			Argillaceous greensand, packed with *Venericardia potapacoensis*	1	
			Dark glauconitic clay	3	
			Layer of *Venericardia potapacoensis*		8
			Greensand with many scattered specimens of *Venericardia potapacoensis*	3	
			Line of concretions		6
			Glauconitic clay with *Venericardia potapacoensis*	4	
			Dark greensand	5	
			Layer packed with shells of *Venericardia potapacoensis*	1	6
			Argillaceous greensand	1	
			Line of concretions		6
			Argillaceous greensand	3	
			Greensand with *Venericardia potapacoensis*	1	
			Dark glauconitic clay	.3	
			Layer of shells of *Venericardia potapacoensis*		4
			Dark clay, with much glauconite	—	—
			Total	74	6

Section on bank of Patuxent River one-quarter mile below mouth of Lyons Creek, Calvert County.

			Feet.	Inches.
Pleistocene.		Sand and gravel	6	
Neocene.	Miocene.	Diatomaceous clay	9	
		Siliceous indurated stratum with Miocene fossils		10
		Brown gritty clay, with abundant casts of Miocene fossils	4	
Eocene.	Nanjemoy.	Argillaceous greensand, with abundant casts of Nanjemoy fossils	10	
		Line of concretions		2
		Argillaceous greensand and talus	20	
		Total	50	0

FIG. 1.—LOWER EOCENE DEPOSITS ON SEVERN RIVER.

FIG. 2.—INDURATED LAYER AT UPPER MARLBORO, OVERLYING BRYOZOAN SAND.

VIEWS OF EOCENE SECTIONS.

Section on South River at mouth of Broad Creek, Anne Arundel County.

				Feet.
Eocene.	Aquia.	Piscataway.	Ferruginous sandstone full of casts of *Turritella mortoni*, *Venericardia planicosta var. regia*, *Crassatellites alaeformis*, *etc*	10
			Coarse oxidized greensand with occasional casts of *Venericardia planicosta var. regia*	24
			Talus	24
			Total	58

Section on north bank of Severn River one mile above railroad bridge, Anne Arundel County.

				Feet.
Pleistocene.			Sand and loam	5
Eocene.	Aquia.	Piscataway.	Coarse red, glauconitic sand partially indurated, with *Ostrea compressirostra*, *Cucullaea gigantea*, *Meretrix ovata var. pyga*, *Turritella mortoni*, *etc*,	20
			Red glauconitic sand and talus	50
			Total	75

Section on Chester River opposite Rolphs Landing, Kent County.

				Feet.
Pleistocene.			Sand and loam	5
Neocene?			Drab clay with a thin band of limonite at the base	1
Eocene.	Aquia.	Paspotansa.	Coarse yellowish-red glauconitic sand irregularly indurated and with occasional pockets of coarse bright green glauconitic sand	4
			Very coarse indurated glauconitic sand, much oxidized and iron-stained, with abundant augular quartz pebbles, frequently ¼ inch in diameter, and with abundant casts of fossils, including *Turritella mortoni*, *Panopea elongata*, *Protocardia lenis*, *Venericardia planicosta var. regia*, *Crassatellites alaeformis*, *Glycymeris idoneus and Cucullaea gigantea*	3
			Oxidized glauconitic sand, with occasioual tubes of *Vermetus*	7
			Total	20

Geological and Geographical Distribution of Species.

The geological and geographical distribution of the species obtained from the Maryland Eocene has already been indicated in a general way in the discussion of the various stages, substages and zones. A much more complete presentation of the distribution of all the forms is given in the accompanying tables and in the chapter on systematic paleontology with which the report closes. Any further attempt at a discussion of the subject at this time would lead to much needless repetition.

LOCAL DISTRIBUTION.

AQUIA FORMATION.

SPECIES.	PISCATAWAY STAGE.																	PASPOTANSA STAGE.																						
	Fort Washington.	Seat Pleasant (Railroad cut).	Brooks estate, near Seat Pleasant.	Piscataway Creek.	Swan Creek, near Piscataway.	Glymont.	Aquia Creek.	Liverpool Point.	Reedy Run.	Clifton Beach.	Wades Bay.	Leeland.	Three miles west of Leeland.	Collington.	One mile N. E. of Grimesville.	Three miles W. of Pisgah.	Winchester.	Fredericktown Cecil Co.	One mile N. E. of Piscataway.	Tinkers Creek, near Piscataway.	Pomonkey Neck.	One mile S. E. of Mason Springs.	Potomac Creek.	Two miles below Potomac Creek.	Paspotansa Creek.	Mattawoman Creek.	Upper Marlboro.	Hardesty.	One mile west of Hardesty.	Between Buena Vista and Collington.	Crownsville.	Two miles south of South River.	South River (mouth of Broad Creek).	South River (Sheckels farm).	Annapolis.	Severn River.	Rolphs Landing.	Harrisons Landing.	Southeast Creek.
REPTILIA.																																							
Thecachampsa sp.								*																															
Thecachampsa sericodon ? Cope										*																													
Thecachampsa contusor Cope							*																																
Thecachampsa marylandica Clark										*																	*												
Euclastes ? sp.										*																													
Trionyx virginiana Clark							*																																
PISCES.																																							
Myliobatis copeanus Clark							*	*		*													*																
Aetobatis arcuatus Agassiz							*																																
Synechodus clarkii Eastman								*																															
Odontaspis elegans (Agassiz)	*						*																																
Odontaspis macrota (Agassiz)	*						*	*																															
Odontaspis cuspidata (Agassiz)	*																									*													
Otodus obliquus Agassiz							*	*																															
Carcharodon auriculatus (Bln.)																																							
Galeocerdo latidens Agassiz																																							
Sphyrna prisca Agassiz								*																															
Xiphias ? radiata (Clark)										*																													
ARTHROPODA. Ostracoda.																																							
Bythocypris subacquata Ulrich																											*												
Bythocypris parilis Ulrich																											*												
Cytherella marlboroensis Ulrich																											*												
Cytherella submarginata Ulrich																											*												
Cythere marylandica Ulrich			*																								*												
Cythereis bassleri Ulrich																											*												
Cytheridea perarcuata Ulrich																							*																
MOLLUSCA. Cephalopoda.																																							
Hercoglossa tuomeyi C. & M.										*																													
MOLLUSCA. Gastropoda.																																							
Tornatellaea bella Conrad							*												*				*				*												
Ringicula dalli Clark																																							
Cylichna venusta Clark										*									*			*	*	*															
Pleurotoma harrisi Clark																						*	*	*															
Pleurotoma potomacensis C. & M.																			*					*															
Pleurotoma ducateli C. & M.																						*																	
Pleurotoma childreni Lea																						*		*															
Pleurotoma piscatavensis C. & M.																			*																				
Pleurotoma tysoni C. & M.																						*																	
Mangilia bellistriata Clark																							*																
Cancellaria graciloides Ald. *var.*																						*																	
Cancellaria sp.																							*	*															
Cancellaria potomacensis C. & M.																						*																	
Olivula sp.																																							
Volutilithes petrosus (Conrad)							*												*			*	*	*															
Volutilithes sp.							*																*																
Caricella pyruloides ? (Conrad)							*	*															*																
Mitra marylandica ? Clark																					*																		
Mitra pomonkensis C. & M.																			*		*		*	*															
Mitra potomacensis C. & M.																			*																				
Latirus marylandicus C. & M.																								*															
Fusus ? subtenuis Heilprin																								*															
Fusus ? interstriatus Heilprin							*												*																				
Trophon sublevis Harris																			*																				
Strepsidura subscalarina Heilprin								*															*	*			*												
Melongena ? potomacensis C. & M.																							*																

SPECIES.	LOCAL DISTRIBUTION.																			GENERAL DISTRIBUTION.											
	NANJEMOY FORMATION.																														
	POTAPACO STAGE.							?						WOODSTOCK STAGE.						MARYLAND PROVINCE.				GULF PROVINCE.							
	Potomac Creek. Zones 11-13.	Nanjemoy Creek.	West of Port Tobacco.	East of Port Tobacco.	Half mile below Chapel Point.	2½ miles above Popes Creek.	Woodstock. Zone 15.	One mile S. E. of Piscataway.	Ravine north of Thrift.	Charles Branch, between Rosaryville and Upper Marlboro.	Upper Marlboro (S. W. of town).	Upper Marlboro (deep cut on new R. R.).	Hills Bridge.	La Plata.	Woodstock. Zones 16 and 17.	Two miles above Popes Creek.	1½ miles above Popes Creek.	Popes Creek.	Deep well at Chesapeake Beach (90-92 feet).	Piscataway stage.	Paspotansa stage.	Potapaco stage.	Woodstock stage.	Cretaceous.	Midwayan.	Lower Chickasawan.	Upper Chickasawan.	Lower Claibornian.	Upper Claibornian.	Jacksonian.	Post-Eocene.
REPTILIA.																															
Thecachampsa sp.																				*											
Thecachampsa sericodon ? Cope																				*											
Thecachampsa contusor Cope																				*											
Thecachampsa marylandica Clark																				*	*										
Euclastes ? sp.																				*											
Trionyx virginiana Clark																				*											
PISCES.																															
Myliobatis copeanus Clark															*					*	*		*								
Aetobatis arcuatus Agassiz																		*		*			*								
Synechodus clarkii Eastman																				*											
Odontaspis elegans (Agassiz)																				*											
Odontaspis macrota (Agassiz)															*					*			*								
Odontaspis cuspidata (Agassiz)															*			*		*	*		*								
Otodus obliquus Agassiz																				*											
Carcharodon auriculatus (Bln)																		*					*								
Galeocerdo latidens Agassiz															*								*								
Sphyrna prisca Agassiz																				*											
Xiphias ? *radiata* (Clark)																				*											
ARTHROPODA. Ostracoda.																															
Bythocypris subaequata Ulrich																					*										
Bythocypris parilis Ulrich																					*										
Cytherella marlboroensis Ulrich																					*										
Cytherella submarginata Ulrich																					*										
Cythere marylandica Ulrich																				*	*										
Cythereis bassleri Ulrich																					*										
Cytheridea perarcuata Ulrich															*						*		*								
MOLLUSCA. Cephalopoda.																															
Hercoglossa tuomeyi C. & M.																		*		*			*								
MOLLUSCA. Gastropoda.																															
Tornatellaea bella Conrad			*				*	*							?					*	*	*	?		*[1]	*[3]	*[3]				
Ringicula dalli Clark															*								*								
Cylichna venusta Clark		*	*				*								?					*	*	*	?								
Pleurotoma harrisi Clark																					*										
Pleurotoma potomacensis C. & M.																					*					?[3]					
Pleurotoma ducateli C. & M.																					*										
Pleurotoma childreni Lea																					*					*[3]	*[3]		*		
Pleurotoma piscatavensis C. & M.																					*										
Pleurotoma tysoni C. & M.																					*										
Mangilia bellistriata Clark																		*			*		*								
Cancellaria graciloides var. Ald																					*					*[3]		?[5]	?		
Cancellaria sp.																					*										
Cancellaria potomacensis C. & M.																					*										
Olivula sp.																		*					*				?[3]	?[4]			
Volutilithes petrosus (Conrad)			*												*			*		*	*	*	*			*[3]	*[3]	*[4]			
Volutilithes sp.																				*	*										
Caricella pyruloides ? (Conrad)																				*	*					*[3]		*[4]	*		
Mitra marylandica Clark																					*										
Mitra pomonkensis C. & M.																					*										
Mitra potomacensis C. & M.															*			*			*		*								
Latirus marylandicus C. & M.																					*										
Fusus ? *subtenuis* Heilprin																					*					*[3]	*[3]				
Fusus ? *interstriatus* Heilprin															*						*		*				*[3]				
Trophon sublevis Harris																					*					*[3]					
Strepsidura subscalarina Heilprin															*			*		*	*		*			*[3]	*[3]				
Melongena ? *potomacensis* C. & M.																					*										

[1] Harris: Bull. Amer. Pal., No. 4. [3] Harris: Bull. Amer. Pal., No. 11. [4] Aldrich: Coastal Plain, Alabama.
[5] Harris: Proc. Acad. N. Sci., Phila., 1895,

SPECIES.	Fort Washington.	Seat Pleasant (Railroad cut).	Brooks estate, near Seat Pleasant.	Piscataway Creek.	Swan Creek, near Piscataway.	Glymont.	Aquia Creek.	Liverpool Point.	Reedy Run.	Clifton Beach.	Wades Bay.	Leeland.	Three miles west of Leeland.	Collington.	One mile N. E. of Grimesville.	Three miles W. of Pisgah.	Winchester.	Fredericktown, Cecil Co.	One mile N. E. of Piscataway.	Tinkers Creek, near Piscataway.	Pomonkey Neck.	One mile S. E. of Mason Springs.	Potomac Creek.	Two miles below Potomac Creek.	Paspotansa Creek.	Mattawoman Creek.	Upper Marlboro.	Hardesty.	One mile west of Hardesty.	Between Buena Vista and Collington.	Crownsville.	Two miles south of South River.	South River (mouth of Broad Creek).	South River (Sheckels farm).	Annapolis.	Severn River.	Rolphs Landing.	Harrisons Landing.	Southeast Creek.
	LOCAL DISTRIBUTION.																																						
	AQUIA FORMATION.																																						
	PISCATAWAY STAGE.																	PASPOTANSA STAGE.																					
MOLLUSCA. Gastropoda.—*Cont.*																																							
Tudicla marylandica C. & M.																							*																
Tudicla sp.	*						*			*																					*								
Tudicla ? sp.							*			*																													
Levifusus trabeatus ? Conrad																																							
Levifusus trabeatus ? var. Conrad																																							
Metula marylandica C. & M.																						*	*	*															
Chrysodomus engonatus (Heilprin)																							*	*															
Pseudoliva sp.																											*	*											
Tritonium showalteri (Conrad)																								*	*														
Pyrula penita var. Conrad																																							
Pyrula ? sp.																																							
Fulguroficus argutus Clark																					*		*	*			*												
Fusoficula juvenis (Whitfield)																								*															
Morio brevidentata (Aldrich)																						*		*															
Cypraea smithi Aldrich																																							
Calyptraphorus jacksoni Clark																											*							*					
Calyptraphorus trinodiferus Con.																							*	*															
Calyptraphorus trinodiferus ? var.																						*																	
Aporrhais potomacensis C. & M.																			*				*	*															
Turritella mortoni Conrad	*		*			*	*	*		*									*	*		*	*				*		*					*			*		
Turritella humerosa Conrad	*		*			*	*	*		*									*	*		*			*		*			*				*					
Turritella potomacensis C. & M.																																							
Mesalia obruta (Conrad)																											*							*					
Vermetus sp.				*																			*				*										*		
Natica cliftonensis Clark										*																													
Lunatia marylandica Conrad	*					*	*	*											*			*	*	*	*		*	*											
Calyptraea aperta (Solander)	*					*	*	*		*												*	*	*			*												
Litiopa marylandica C. & M.																								*															
Solarium sp.							*															*																	
Scala virginiana Clark							*																*																
Scala potomacensis C. & M.																								*															
Scala sessilis Conrad																								*															
Scala carinata Lea																								*			*												
Turbonilla potomacensis C. & M.																							*	*															
Tuba marylandica C. & M.																						*			*														
Odostomia trapaquara (Harris)																							*	*			*												
Niso umbilicata (Lea)																							*																
Gibbula glandula (Conrad)				*																			*				*												
Calliostoma sp.																								*			*												
Fissuridea marlboroensis C. & M.																											*												
MOLLUSCA. Scaphopoda.																																							
Dentalium minutistriatum Gabb																																							
Dentalium mississippiensis Con.																											*												
Cadulus abruptus Meyer & Aldrich							*	*		*									*																				
MOLLUSCA. Pelecypoda.																																							
Teredo virginiana Clark										*									*			*		*			*												
Phenacomya petrosa (Conrad)	*			*			*			*																													
Gastrochaena sp.							*																				*												
Panopea elongata Conrad	*	*		*		*	*			*							*		*	*	*	*	*	*	*		*	*									*		
Corbula subengonata Dall						*				*									*			*		*		*													
Corbula aldrichi Meyer							*	*		*																													
Corbula oniscus Conrad						*																																	
Solen lisbonensis ? Aldrich																																							
Tellina virginiana Clark	*						*			*											*			*															
Tellina williamsi Clark																							*																
Tellina papyria ? Conrad	*																																						
Meretrix lenis (Conrad)																																							

SPECIES.	LOCAL DISTRIBUTION.																			GENERAL DISTRIBUTION.											
	NANJEMOY FORMATION.																														
	POTAPACO STAGE.							?						WOODSTOCK STAGE.						MARYLAND PROVINCE.					GULF PROVINCE						
	Potomac Creek. Zones 11-13.	Nanjemoy Creek.	West of Port Tobacco.	East of Port Tobacco.	Half mile below Chapel Point.	2½ miles above Popes Creek.	Woodstock. Zone 15.	One mile S. E. of Piscataway.	Ravine north of Thrift.	Charles Branch, between Rosaryville and Upper Marlboro.	Upper Marlboro (S. W. of town).	Upper Marlboro (deep cut on new R. R.).	Hills Bridge.	La Plata.	Woodstock. Zones 16 and 17.	Two miles above Popes Creek.	1½ miles above Popes Creek.	Popes Creek.	Deep well at Chesapeake Beach (90-92 feet).	Piscataway stage.	Paspotansa stage.	Potapaco stage.	Woodstock stage.	Cretaceous.	Midwayan.	Lower Chickasawan.	Upper Chickasawan.	Lower Claibornian.	Upper Claibornian.	Jacksonian.	Post-Eocene.
MOLLUSCA. Gastropoda.—*Cont.*																															
Tudicia marylandica C. & M.																					*										
Tudicla sp. Conrad																				*											
Tudicla ? sp.																		*		*			*								
Levifusus trabeatus ? Conrad																		*					*			*[3]	*[3]	*[4]			
Levifusus trabeatus var. ? Conrad															*								*								
Metula marylandica C. & M.																					*										
Chrysodomus engonatus (Heilprin)																					*					*[3]	*[3]	*[3]			
Pseudoliva sp.																					*										
Tritonium showalteri (Conrad)																					*										
Pyrula penita var. Conrad																		*					*					*[4]	*		
Pyrula ? sp.																		*					*								
Fulguroficus argutus Clark															?						*		?			?	?				
Fusoficula juvenis (Whitfield)																					*				*[1]	*[3]	*[3]				
Morio brevidentata (Aldrich)																					*					*[3]					
Cypraea smithi Aldrich		*	*		*																	*				*[3]	*[3]				
Calyptraphorus jacksoni Clark																					*										
Calyptraphorus trinodiferus Con.	*																				*	*				*[3]	*[3]				
Calyptraphorus trinodiferus var ?																		*			*		*		?			?	?		
Aporrhais potomacensis C. & M																					*										
Turritella mortoni Conrad																				*	*				*[1]	*[3]	*[3]	*[4]			
Turritella humerosa Conrad																				*	*				*[1]	*[3]	*[3]	*[4]			
Turritella potomacensis C. & M.															*			*					*								
Mesalia obruta (Conrad)															*			*			*		*					*[4]	*		
Vermetus sp.																				*	*										
Natica cliftonensis Clark															?					*			?								
Lunatia marylandica Conrad			*	*			*								?					*	*	*	?			*[3]	*[3]	*[4]	*		
Calyptraea aperta (Solander)			*	*	*										*			*		*	*	*	*			*[3]	*[3]	*[4]	*		*
Litiopa marylandica C. & M.																					*										
Solarium sp.																				*	*										
Scala virginiana Clark																				*	*										
Scala potomacensis C. & M.																					*										
Scala sessilis Conrad																					*										
Scala carinata Lea																					*										
Turbonilla potomacensis C. & M.																					*										
Tuba marylandica C. & M.																		*			*		*								
Odostomia trapaquara (Harris)																					*							*[5]			
Niso umbilicata (Lea)																					*					*[3]	*[3]		*		
Gibbula glandula (Conrad)																				*	*										
Calliostoma sp.																					*										
Fissuridea marlboroensis C. & M.																					*										
MOLLUSCA. Scaphopoda.																															
Dentalium minutistriatum Gabb																		*					*								
Dentalium mississippiensis Con.			*					*													*	*									
Cadulus abruptus Meyer & Aldrich		*	*	*		*		*							*		*		*	*	*	*	*			*[3]	*[3]	*[4]		*	
MOLLUSCA. Pelecypoda.																															
Teredo virginiana Clark			*			*						*	*		*			*			*	*	*								
Phenacomya petrosa (Conrad)																				*											
Gastrochaena sp.																				*	*										
Panopea elongata Conrad																				*	*										
Corbula subengonata Dall															*			*		*	*		*			*[2]					
Corbula aldrichi Meyer		*	*	*	*	*		*				*			*		*	*		*	*	*	*			*[2]	*[2]	?[5]			
Corbula oniscus Conrad		*	*	*		*		*				*	?		*			*		*		*	*					*[4]	*	*	
Solen lisbonensis ? Aldrich					*		*								?							*	?				?[7]	?	?[7]		
Tellina virginiana Clark			*	*		*				*					*			*		*	*	*	*								
Tellina williamsi Clark						*									*			*			*	*	*								
Tellina papyria ? Conrad																				*									?		
Meretrix lenis (Conrad)									?						*								*								

Harris: Bull. Amer. Pal., No. 4. [2] Harris: Bull. Amer. Pal., No. 9. [3] Harris: Bull. Amer. Pal., No. 11.
Aldrich: Coastal Plain, Alabama. [5] Harris: Proc. Acad. N. Sci., Phila., 1895. [7] Dall: Trans. Wag. Free Inst., vol. iii, pt. v.

LOCAL DISTRIBUTION.

AQUIA FORMATION.

	PISCATAWAY STAGE.																	PASPOTANSA STAGE.																					
SPECIES.	Fort Washington.	Seat Pleasant (Railroad cut).	Brooks estate, near Seat Pleasant.	Piscataway Creek.	Swan Creek, near Piscataway.	Glymont.	Aquia Creek.	Liverpool Point.	Reedy Run.	Clifton Beach.	Wades Bay.	Leeland.	Three miles west of Leeland.	Collington.	One mile N. E. of Grimesville.	Three miles W. of Pisgah.	Winchester.	Fredericktown, Cecil Co.	One mile N. E. of Piscataway.	Tinkers Creek, near Piscataway.	Pomonkey Neck.	One mile S. E. of Mason Springs.	Potomac Creek.	Two miles below Potomac Creek.	Paspotansa Creek.	Mattawoman Creek.	Upper Marlboro.	Hardesty.	One mile west of Hardesty.	Between Buena Vista and Collington.	Crownsville.	Two miles south of South River.	South River (mouth of Broad Creek).	South River (Sheckels farm).	Annapolis.	Severn River.	Rolphs Landing.	Harrisons Landing.	Southeast Creek.
MOLLUSCA. Pelecypoda.—*Continued.*																																						
Meretrix ovata var. ovata (Rogers)																																						
Meretrix ovata var. pyga Conrad	*		*			*	*	*	*	*					*							*	*	*	*	?	*	*						*					
Meretrix subimpressa Conrad																																						
Dosiniopsis lenticularis (Rogers)	*		*			*	*	*	*	*					*	*		*	*				*			*	*	*	*					*				*	
Protocardia lenis Conrad							*												*			*	*	*	*		*										*		
Diplodonta marlboroensis C. & M.																											*							*					
Lucina aquiana Clark							*																				*												
Lucina astartiformis Aldrich																																						
Lucina dartoni Clark																																						
Lucina uhleri Clark						*		*		*									*			*	*	*		*	*												
Lucina whitei Clark																																						
Lucina sp.																																						
Venericardia planicosta var. regia Con.	*			*			*							*				*	*				*	*	*		*	*	*				*	*		*	*		
Venericardia marylandica C. & M.																																						
Venericardia potapacoensis C. & M.																																						
Crassatellites alaeformis (Conrad)	*		*			*	*	*		*	*		*						*			*	*	*	*	*	*			*				*			*		
Crassatellites aquiana (Clark)			*			*	*	*	*														*			*													
Crassatellites alta (Conrad)																											?	*											
Crassatellites sp										*																													
Astarte marylandica Clark			*																								*							*					
Coralliophaga bryani Clark																					*	*																	
Periploma? sp.																																						
Pholadomya marylandica Con.	*			*			*			*																													
Modiolus alabamensis Ald.	*					*	*	*		*	*											*	*	*	*		*												
Modiolus marylandicus C. & M.																																						
Lithophaga marylandica C. & M.										*																													
Anomia marylandica C. & M.										*																													
Pecten choctavensis Aldrich																			*								*												*
Pecten dalli Clark																							*																*
Pecten johnsoni Clark																							*	*	*														
Pecten sp.																							*																
Ostrea compressirostra Say	*		*		*	*	*	*	*	*	*	*	*		*	*			*	*		*	*	*	*	*	*	*						*		*			
Ostrea compressirostra var. alepidota Dall	*						*																																
Ostrea sellaeformis Conrad																																						
Ostrea (Gryphaeostrea) vomer (Morton)				*		*	*											*					*	*			*							*					
Gryphaea vesicularis Lamarck										*																													
Pteria limula (Conrad)																											*												
Glycymeris idoneus (Conrad)																			*				*				*	*	*					*			*		
Trigonoarca decisa (Con.) *var.*																																						
Cucullaea gigantea Conrad	*					*	*	*		*			*					?	*			*	*	*	*		*		*					*			*		
Leda parva (Rogers)																																						
Leda cultelliformis (Rogers)							*																																
Leda improcera (Conrad)																																						
Leda parilis (Conrad)																											*							*					
Leda parilis var																																						
Leda potomacensis C. & M.																																						
Leda cliftonensis C. & M.							*	*		*													*	*															
Leda tysoni C. & M.																																						
Nucula ovula Lea																											*							*					
Nucula potomacensis C. & M.																																						
MOLLUSCOIDEA. Brachiopoda.																																						
Terebratula harlani Morton													*																						*				
Platidia marylandica C. & M.																											*												
MOLLUSCOIDEA. Bryozoa.																																						
Discosparsa varians Ulrich																											*												
Fascipora subramosa Ulrich																											*												
Reticulipora dichotoma G. & H.																											*												
Cavaria dumosa Ulrich																											*												

SPECIES.	LOCAL DISTRIBUTION. NANJEMOY FORMATION. POTAPACO STAGE.							?						WOODSTOCK STAGE.						GENERAL DISTRIBUTION. MARYLAND PROVINCE.					GULF PROVINCE.						
	Potomac Creek. Zones 11-13.	Nanjemoy Creek.	West of Port Tobacco.	East of Port Tobacco.	Half mile below Chapel Point.	2½ miles above Popes Creek.	Woodstock. Zone 15.	One mile S. E. of Piscataway.	Ravine north of Thrift.	Charles Branch, between Rosaryville and Upper Marlboro.	Upper Marlboro (S. W. of town).	Upper Marlboro (deep cut on new R. R.).	Hills Bridge.	La Plata.	Woodstock. Zones 16 and 17.	Two miles above Popes Creek.	1½ miles above Popes Creek.	Popes Creek.	Deep well at Chesapeake Beach (90-92 feet).	Piscataway stage.	Paspotansa stage.	Potapaco stage.	Woodstock stage.	Cretaceous.	Midwayan.	Lower Chickasawan.	Upper Chickasawan.	Lower Claibornian.	Upper Claibornian.	Jacksonian.	Post-Eocene.
MOLLUSCA. Pelecypoda.—*Continued.*																														
Meretrix ovata var. ovata (Rogers)		*	*	*	*	*		*			*	*				*	*	*				*	*			*[2]	*[2]				
Meretrix ovata var. pyga Conrad																				*	*										
Meretrix subimpressa Conrad								*			*				*			*				?	*				*[2]				
Dosiniopsis lenticularis (Rogers)																				*	*					*[2]					
Protocardia lenis Conrad															*			*		*	*		*								
Diplodonta marlboroensis C. & M.																					*										
Lucina aquiana Clark																				*	*					?					
Lucina astartiformis Aldrich								*				*										?	?				*[2]				
Lucina dartoni Clark						*									*			*				*	*								
Lucina uhleri Clark															*			*		*	*		*				*[2]				
Lucina whitei Clark			*		*										*							*	*								
Lucina sp.																		*					*								
Venericardia planicosta var. regia Con.																				*	*				*[1]	*[2]	*[2]	?	?	?	
Venericardia marylandica C. & M.						*	?								?	*		*				?	*								
Venericardia potapacoensis C. & M.	*	*	*	*	*			*			*			*	*	*		*				*	*								
Crassatellites alaeformis (Conrad)																				*	*										
Crassatellites aquiana (Clark)																				*	*										
Crassatellites alta (Conrad)																					*							*[4]	*		
Crassatellites sp.																				*											
Astarte marylandica Clark																				?	*										
Coralliophaga bryani Clark																					*										
Periploma? sp.				*			*								?							*	?								
Pholadomya marylandica Con.																				*											
Modiolus alabamensis Ald						*									*			*		*	*	?	*				*[2]				
Modiolus marylandicus C. & M.															*								*								
Lithophaga marylandica C. & M.																				*											
Anomia marylandica C. & M.															*			*		*			*								
Pecten choctavensis Aldrich																	*	*			*		*				*[2]				
Pecten dalli Clark												*			*						*	?	?							*[6]	
Pecten johnsoni Clark															*						*		*			*	?				
Pecten sp.																					*										
Ostrea compressirostra Say																				*	*					*[2]	*[2]				
Ostrea compressirostra var. alepidota Dall																				*											
Ostrea sellaeformis Conrad				*		*						*			*		*	*				*	*				?[4]	*[4]	*		
Ostrea (Gryphaeostrea) vomer (Morton)					*															*	*	*		*[6]						*[6]	
Gryphaea vesicularis Lamarck																				*				*							
Pteria limula (Conrad)													*					*			*		*				*[2]	*[4]	*		
Glycymeris idoneus Conrad															*			*			*		*		*[1]	*[2]	*[2]	?[4]			
Trigonoarca decisa var. Con.															*								*				*[2]	[4]*[5]			
Cucullaea gigantea Conrad															*			*		*	*		*			*[2]					
Leda parva (Rogers)															*	*		*					*			*[2]	*[2]				
Leda cultelliformis (Rogers)												*			*	*		*		*		?	*								
Leda improcera (Conrad)		*				*									*			*				*	*								
Leda paritis Conrad																					*										
Leda parilis var.													*		*							?	*								
Leda potomacensis C. & M.			*		*			*		*					*			*				*	*				*[6]				
Leda cliftonensis C. & M.																				*	*										
Leda tysoni C. & M.						*		*							*			*				*	*								
Nucula ovula Lea																					*				*[1]	*[2]	*[2]	*[4]	*		
Nucula potomacensis C. & M.		*	*	*		*				*		*			*			*				*	*								
MOLLUSCOIDEA. Brachiopoda.																															
Terebratula harlani Morton																					*				*						
Platidia marylandica C. & M.																						*									
MOLLUSCOIDEA. Bryozoa.																															
Discosparsa varians Ulrich																					*			*[9]							
Fascipora subramosa Ulrich																					*										
Reticulipora dichotoma G. & H.																					*			*[9]							
Cavaria dumosa Ulrich																					*										

[1] Harris: Bull. Amer. Pal., No. 4. [2] Harris: Bull. Amer. Pal., No. 9. [4] Aldrich: Coastal Plain, Alabama.
[5] Harris: Proc. Acad. N. Sci., Phila., 1895. [6] Dall: Trans. Wag. Free Inst., vol. iii, pt. iv.

SPECIES.	Fort Washington.	Seat Pleasant (Railroad cut).	Brooks estate, near Seat Pleasant.	Piscataway Creek.	Swan Creek, near Piscataway.	Glymont.	Aquia Creek.	Liverpool Point.	Reedy Run.	Clifton Beach.	Wades Bay.	Leeland.	Three miles west of Leeland.	Collington.	One mile N. E. of Grimesville.	Three miles W. of Pisgah.	Winchester.	Fredericktown, Cecil Co.	One mile N. E. of Piscataway.	Tinkers Creek, near Piscataway.	Pomonkey Neck.	One mile S. E. of Mason Springs.	Potomac Creek.	Two miles below Potomac Creek.	Paspotansa Creek.	Mattawoman Creek.	Upper Marlboro.	Hardesty.	One mile west of Hardesty.	Between Buena Vista and Collington.	Crownsville.	Two miles south of South River.	South River (mouth of Broad Creek).	South River (Sheckels farm).	Annapolis.	Severn River.	Rolphs Landing.	Harrisons Landing.	Southeast Creek.
	LOCAL DISTRIBUTION.																																						
	AQUIA FORMATION.																																						
	PISCATAWAY STAGE.																	PASPOTANSA STAGE.																					
MOLLUSCOIDEA. Bryozoa.—*Continued.*																																							
Ceriopora micropora Goldf																																							
Heteropora ? tecta Ulrich																											*												
Membranipora rimulata Ulrich																											*												
Membranipora spiculosa Ulrich																											*												
Membranipora angusta Ulrich																											*												
Reptoflustrella heteropora G. & H.																											*												
Biflustra torta G. & H.																											*												
Eschara ? digitata Morton																											*												
Lunulites reversa Ulrich																								*															
Cribrilina modesta Ulrich																											*												
Cribrilina crassula Ulrich																											*												
Lepralia subplana Ulrich																											*												
Lepralia labiosa Ulrich																											*												
Mucronella aspera Ulrich																											*												
COELENTERATA.																																							
Flabellum sp.							*																																
Turbinolia acuticostata Vaughan																							*																
Trochocyathus clarkeanus Vaughan							*												*				*																
Paracyathus marylandicus Vaughan																			*																				
Balanophyllia desmophyllum M-E & H.																						*																	
Eupsammia elaborata (Conrad)							*															*	*				*												
PROTOZOA.																																							
Textularia gramen d'Orbigny																			*								*												
Textularia sagittula Defrance																											*												
Textularia subangulata d'Orbigny			*																																				
Spiroplecta clarki Bagg																																							
Nodosaria affinis (d'Orbigny)																																							
Nodosaria bacillum Defrance													*								*	*		*			*												
Nodosaria communis (d'Orbigny)			*																								*												
Nodosaria consorbrina v. emaciata (Reuss)																											*												
Nodosaria sandbergeri (Reuss)																											*												
Nodosaria obliqua (Linné)																											*												
Vaginulina legumen (Linné)			*																																				
Marginula costata (Batsck)																											*												
Cristellaria gibba d'Orbigny																			*								*												
Cristellaria rotatula (Lamarck)																						*					*												
Cristellaria radiata (Bornemann)																																							
Polymorphina austriaca (d'Orbigny)																																							
Polymorphina communis d'Orbigny																											*												
Polymorphina compressa d'Orbigny																																							
Polymorphina elegantissima P. & J.																																							
Polymorphina gibba d'Orbigny			*																								*												
Polymorphina lactea (W. & J.)																											*												
Polymorphina praelonga Terq.																																							
Globigerina bulloides d'Orbigny																																							
Discorbina bertheloti (d'Orbigny)																																							
Discorbina turbo (d'Orbigny)																											*												
Truncatulina lobatula (W. & J.)																											*												
Truncatulina ungeriana (d'Orbigny)			*																								*												
Anomalina ammonoides (Reuss)																											*												
Anomalina grosserugosa (Gümbel)																			*																				
Pulvinulina exigua var. obtusa Bur.																			*																				
Pulvinulina schreibersii (d'Orbigny)																																							
Nonionina affinis Reuss																																							
Amphistegina lessonii d'Orbigny																																							
PLANTAE.																																							
Carpolithus marylandicus Hollick																																							
Carpolithus marylandicus var. rugosus H.																																							

SPECIES.	LOCAL DISTRIBUTION.																			GENERAL DISTRIBUTION.											
	NANJEMOY FORMATION.																														
	POTAPACO STAGE.							?						WOODSTOCK STAGE.						MARYLAND PROVINCE.					GULF PROVINCE.						
	Potomac Creek. Zones 11-13.	Nanjemoy Creek.	West of Port Tobacco.	East of Port Tobacco.	Half mile below Chapel Point.	2½ miles above Popes Creek.	Woodstock. Zone 15.	One mile S. E. of Piscataway.	Ravine north of Thrift.	Charles Branch, between Rosaryville and Upper Marlboro.	Upper Marlboro (S. W. of town).	Upper Marlboro (deep cut on new R. R.).	Hills Bridge.	La Plata.	Woodstock. Zones 16 and 17.	Two miles above Popes Creek.	1½ miles above Popes Creek.	Popes Creek.	Deep well at Chesapeake Beach (90-92 feet).	Piscataway stage.	Paspotansa stage.	Potapaco stage.	Woodstock stage.	Cretaceous.	Midwayan.	Lower Chickasawan.	Upper Chickasawan.	Lower Claibornian.	Upper Claibornian.	Jacksonian.	Post-Eocene.
MOLLUSCOIDEA. Bryozoa.—*Continued.*																															
Ceriopora micropora Goldf.						*																*		*[10]							
Heteropora ? tecta Ulrich																					*										
Membranipora rimulata Ulrich																					*										
Membranipora spiculosa Ulrich																					*										
Membranipora angusta Ulrich																					*										
Reptoflustrella heteropora G. & H.																					*			*[9]							
Biflustra torta G. & H.																					*			*[9]							
Eschara ? digitata Morton																					*			*[9]							
Lunulites reversa Ulrich																					*										
Cribrilina modesta Ulrich																					*										
Cribrilina crassula Ulrich																					*										
Lepralia subplana Ulrich																					*										
Lepralia labiosa Ulrich																					*										
Mucronella aspera Ulrich																					*			*[9]							
COELENTERATA.																															
Flabellum sp.								*							*					*		*									
Turbinolia acuticostata Vaughan																		*			*		*								
Trochocyathus clarkeanus Vaughan																				*	*										
Paracyathus marylandicus Vaughan																					*										
Balanophyllia desmophyllum M-E & H.																					*					*[8]	*[8]	*[8]			
Eupsammia elaborata (Conrad)																				*	*					*[8]	*[8]				
PROTOZOA.																															
Textularia gramen d'Orbigny																					*										
Textularia sagittula Defrance																					*										
Textularia subangulata d'Orbigny																				*											
Spiroplecta clarki Bagg															*								*								
Nodosaria affinis (d'Orbigny)															*								*								
Nodosaria bacillum Defrance															*					*	*		*								
Nodosaria communis (d'Orbigny)																				*	*										
Nodosaria consorbrina v. emaciata (Reuss)																					*										
Nodosaria sandbergeri (Reuss)																					*										
Nodosaria obliqua (Linné)																					*										
Vaginulina legumen (Linné)																				*											
Marginula costata Batsch.																					*										
Cristellaria gibba d'Orbigny																					*										
Cristellaria rotatula (Lamarck)																					*										
Cristellaria radiata (Bornemann)															*								*								
Polymorphina austriaca (d'Orbigny)															*								*								
Polymorphina communis d'Orbigny															*						*		*								
Polymorphina compressa d'Orbigny															*				*				*								
Polymorphina elegantissima P. & J.															*								*								
Polymorphina gibba d'Orbigny															*					*	*		*								
Polymorphina lactea (W. & J.)																					*										
Polymorphina praelonga Terq.															*								*								
Globigerina bulloides d'Orbigny															*				*				*								
Discorbina bertheloti (d'Orbigny)															*								*								
Discorbina turbo (d'Orbigny)																					*										
Truncatulina lobatula (W. & J.)															*						*		*								
Truncatulina ungeriana (d'Orbigny)																			*	*	*		*								
Anomalina ammonoides (Reuss)																					*										
Anomalina grosserugosa (Gümbel)																					*										
Pulvinulina exigua var. obtusa Bur.																					*										
Pulvinulina schreibersii (d'Orbigny)															*				*				*								
Nonionina affinis Reuss															*								*								
Amphistegina lessonii d'Orbigny															*								*								
PLANTAE.																															
Carpolithus marylandicus Hollick																		*					*								
Carpolithus marylandicus var. rugosus H.																		*					*								

[8] Vaughan: Mono. xxxix, U. S. G. S. [9] "Cretaceous of N. J.," Ulrich, see p. 222. [10] "Maastricht," Ulrich, see p. 210.

Correlation of Deposits.

Numerous attempts have been made to correlate the Eocene deposits of Maryland with those of other areas. Not only has the attempt been made to establish the equivalency between the Maryland deposits and those of adjoining states to the north and south, but also with the more distant Gulf region and with Europe. That the conclusions reached by the various investigators have been widely at variance has already been shown in the Historical Review. Some have considered the strata to represent but a small part of the full Eocene series, while others have regarded them to embrace a considerable portion of the same. These diverse views will be discussed in detail in the subsequent pages.

Two methods of correlation are possible, one based upon physical, the other upon biological criteria. The faunal and floral characteristics of the formations find, therefore, interpretation only as the physical features are clearly understood since the geological and geographical range of species is determined to a large extent by conditions of sedimentation. The physical characteristics of a formation, therefore, bear a close relationship to its contained faunas, and cannot be ignored in the correlation of the deposits.

It is a well-recognized fact that the most trustworthy correlations are those based upon paleontological criteria, still the possibilities of variation in the succession of organic forms in widely separated areas are so great that detailed correlation can seldom be satisfactorily attempted even where general equivalence is recognized. This is particularly true of the Eocene of the Middle Atlantic Slope where, as will be shown later, the range of species is quite different in certain particulars from that hitherto recognized in adjacent provinces. Such being the case, it is evident that whatever aid the physical criteria can afford should be employed in the interpretation of the Maryland Eocene deposits.

CORRELATION OF THE DEPOSITS WITHIN THE MIDDLE ATLANTIC SLOPE.

It has generally been conceded that the Maryland and Virginia Eocene deposits constitute one and the same geologic province, a conclusion which is well borne out by the fact that the strata are practically continuous and that the materials of the deposits and the fossils are

frequently the same. It is evident, however, that the Maryland beds especially form the lower horizons, while the Virginia deposits represent more largely the upper horizons of the Pamunkey group. In other words, the Aquia formation is more strongly developed in Maryland and the Nanjemoy formation more strongly in Virginia, although the Nanjemoy formation is by no means lacking in Maryland and the same is true of the Aquia formation in Virginia. It is apparent that there must have been a gradual transgression of the Eocene deposits southward, since the Aquia formation gradually disappears under the Nanjemoy to the south of the Potomac; on the other hand, the Nanjemoy formation is entirely absent to the northeast of the Patuxent valley, while the Miocene deposits have gradually transgressed over the Eocene from the Potomac valley northward, so that successively older horizons are found in contact with the Miocene in passing from the Potomac basin northeastward toward Delaware, where the Miocene strata ultimately come to rest directly on the Cretaceous deposits. The result of this differential movement is to limit the area of outcrop of the Nanjemoy formation in Maryland to the southern counties of the state, while the Aquia formation is continued across the Chesapeake Bay into the eastern counties as well and finally disappears beneath the Miocene cover not far from the borders of Delaware. It is evident, therefore, that higher Eocene horizons are found in central and southern Virginia than appear in Maryland, a conclusion borne out by the fact that the *Ostrea sellaeformis* zone with its accompanying fossils is much more strongly represented in the valleys of the Pamunkey and James rivers than in the Potomac basin. Thick beds of *Ostrea sellaeformis* are found in the former areas, while only a few representatives of this species appear in the upper zone of the Woodstock substage on the banks of the Potomac.

CORRELATION OF THE DEPOSITS WITH THE EOCENE FORMATIONS OF THE GULF STATES.

By common consent the extensive and diversified series of Eocene deposits found in the Gulf region has come to be regarded as the type not only for the Atlantic Coast region but for the entire country as well. Dr. Dall, basing his conclusions both on his own work and on that of others in this area, has recently adopted the following classification of

American Eocene horizons. The sequence of stages from above downwards as given by him is as follows:

Jacksonian,
Claibornian,
Chickasawan,
Midwayan.

Paleontological Criteria.

A comparison of the Maryland Eocene faunas with those represented in the Gulf area, which have primarily afforded the basis for the classification above given, shows that the Maryland Atlantic Coast Eocene contains a great many species not represented in the Gulf, or of which the exact range there has not been well enough determined for comparison (158 out of 207), while the majority of identical forms (49 in all) are of wide geological range, and are thus of little value in determining the exact age of the deposits. There are enough distinctive species, however, as will be seen from a study of the table, to show that the Maryland Eocene must represent beyond any doubt the Chickasawan with both its upper and lower substages,[1] and that from the Potomac basin southward through Virginia we also have in all probability the Lower Claibornian as well, with its *Ostrea sellaeformis* zone.

Whether higher or lower stages of the Eocene are represented in the Middle Atlantic Slope is a question that cannot be satisfactorily answered. There are no paleontological data that bear on this point, and the other evidence which may be brought forward cannot be regarded as conclusive. The non-fossiliferous zone at the base of the Aquia formation may or may not be older than the Chickasawan, and the highest strata recognized as Eocene in central and southern Virginia have not been sufficiently studied to show whether they are or are not younger than the lower Claibornian.

The following table contains the forms common to the Maryland and Gulf areas:

[1] The *Upper Chickasawan* as here used includes the Hatchetigbee and Woods Bluff (or Bashi) substages, while the *Lower Chickasawan* includes the Bells Landing (or Tuscahoma), Greggs Landing and Nanafalia substages as differentiated in Alabama and Mississippi.

Fig. 1.—CONTACT OF NANJEMOY AND AQUIA FORMATIONS IN VALLEY OF BEARD CREEK, ANNE ARUNDEL COUNTY.

Fig. 2.—CONTACT OF NANJEMOY AND AQUIA FORMATIONS AT UPPER MARLBORO.

VIEWS OF EOCENE SECTIONS.

SPECIES.	Maryland. Aquia.	Nanjemoy.	Gulf Region. Midwayan.	Lower Chickasawan.	Upper Chickasawan.	Lower Claibornian.	Upper Claibornian.	Jacksonian.
Tornatellaea bella Conrad	*	*	*	*	*	....	....	....
Pleurotoma childreni Lea	*	....	....	*	*	....	....	....
Cancellaria graciloides Aldrich var	*	....	....	*	....	*?	*?	....
Volutilithes petrosus (Conrad)	*	*	....	*	*	*	....	....
Caricella pyruloides (Conrad)	*	....	....	*	....	*	*	....
Fusus subtenuis Heilprin	*	....	....	*	*	....	....	....
Fusus interstriatus Heilprin	*	*	....	....	*	....	....	....
Trophon sublevis Harris	*	....	....	*	....	....	....	....
Levifusus trabeatus Conrad	....	*	....	*	*	*	....	....
Chrysodomus engonatus (Heilprin)	*	....	....	*	*	*	....	....
Pyrula penita var Conrad	....	*	....	....	....	*	*	....
Fusoficula juvenis (Whitfield)	*	....	*	*	*	....	....	....
Morio brevidentata (Aldrich)	*	....	....	*	....	....	....	....
Cypraea smithi Aldrich	....	*	....	*	*	....	....	....
Calyptraphorus trinodiferus Conrad	*	*	....	*	*	....	....	....
Turritella mortoni Conrad	*	....	*	*	*	*	*	....
Turritella humerosa Conrad	*	....	*	*	*	*	*	....
Mesalia obruta (Conrad)	*	*	....	....	....	*	....	....
Lunatia marylandica Conrad	*	*	....	*	*	*	*	....
Calyptraea aperta (Solander)	*	*	....	*	*	*	*	....
Odostomia trapaquara (Harris)	*	....	....	*?	*?	*	....	....
Niso umbilicata (Lea)	*	....	....	*	*	....	*	....
Cadulus abruptus Meyer and Aldrich	*	*	....	*	*	*	....	*
Corbula subengonata Dall	*	*	....	*	*	*?	....	....
Corbula aldrichi Meyer	*	*	....	*	*	* var.	....	....
Corbula oniscus Conrad	*	*	....	....	....	*	*	*
Meretrix ovata Conrad	*	*	....	*	*	....	....	....
Meretrix subimpressa (Conrad)	....	*	....	....	*	....	....	....
Dosiniopsis lenticularis (Rogers)	*	....	....	*	....	....	....	....
Lucina aquiana Clark	*	....	....	*?	....	....	....	....
Lucina astartiformis Aldrich	....	*	....	....	*	....	....	....
Lucina uhleri Clark	*	*	....	....	*	....	....	....
Venericardia planicosta var. *regia*[1] Conrad	*	....	....	*	*?	....	....	....
Modiolus alabamensis Aldrich	*	*	....	....	*	....	....	....
Pecten dalli Clark	*	*	....	....	....	....	....	*
Pecten choctavensis Aldrich	*	*	....	....	*	....	....	....
Pecten johnsoni Clark	*	*	....	*	*?	....	....	....
Ostrea compressirostra Say	*	....	....	*	*	....	....	....
Ostrea sellaeformis Conrad	....	*	....	....	*?	*	*	....
Ostrea (Gryphaeostrea) vomer (Morton)	*	*	....	....	....	....	....	*
Pteria limula (Conrad)	*	*	....	....	*	*	*	....
Glycymeris idoneus (Conrad)	*	*	*	*	*	*?	....	....
Trigonoarca decisa (Conrad)	....	*	....	....	*	*	....	....
Cucullaea gigantea Conrad	*	*	....	*	....	....	....	....
Leda parva (Rogers)	....	*	....	*	*	....	....	....
Leda potomacensis Clark and Martin	....	*	....	....	*	....	....	....
Nucula ovula Lea	*	....	*	*	*	*	*	....
Balanophyllia desmophyllum M-E. and H.	*	....	....	*	*	*	....	....
Eupsammia elaborata (Conrad)	*	....	....	*	*	....	....	

[1] The *V. planicosta* of the Middle Atlantic Slope has been divided by the authors of this paper into several species, the *var. regia* being limited to the Aquia stage. The other species have not been recognized in the Gulf region, although further investigation may show one or more of them to exist there.

In the above table and in the following discussion only the mollusca and corals are included. Many of the other species occur outside of the state, but they are not considered here because the facts at hand are not complete enough to base upon them any generalizations concerning the distribution of the forms or any deductions concerning their significance.

Aquia Stage.—The Aquia stage includes the following species that have been found in the Lower Chickasawan of the Gulf, several of which, as will be seen by the table, also range downward into the Midwayan, while others pass upward into the Upper Chickasawan and even into the Claibornian. Some of these forms also, as will be further seen from an examination of the table, are not confined alone to the Aquia, but range on into the Nanjemoy stage. The following Lower Chickasawan species are found in the Aquia:

Tornatellaea bella Conrad.
Pleurotoma childreni Lea.
Cancellaria graciloides Aldrich.
Volutilithes petrosus (Conrad).
Caricella pyruloides (Conrad).
Fusus subtenuis Heilprin.
Trophon sublevis Harris.
Chrysodomus engonatus (Heilprin).
Fusoficula juvenis (Whitfield).
Morio brevedentata (Aldrich).
Calyptraphorus trinodiferus Conrad.
Turritella mortoni Conrad.
Turritella humerosa Conrad.
Lunatia marylandica Conrad.
Calyptraea aperta (Solander).
Niso umbilicata (Lea).
(?) *Odostomia trapaquara*[1] (Harris).
Cadulus abruptus Meyer and Aldrich.
Corbula subengonata Dall.
Corbula aldrichi Meyer.
Meretrix ovata Conrad.
Dosiniopsis lenticularis (Rogers).
Lucina aquiana Clark.
Pecten johnsoni Clark.
Ostrea compressirostra Say.
Glycymeris idoneus (Conrad).
Cucullaea gigantea Conrad.
Leda parva (Rogers).
Nucula ovula Lea.
Balanophyllia desmophyllum M-E. and H.
Eupsammia elaborata (Conrad).

Of these forms a few only are restricted to the Lower Chickasawan, the remainder ranging on into the Upper Chickasawan and some on into the Claibornian as well. The restricted forms are:

Trophon sublevis Harris.
Morio brevidentata (Aldrich).
Dosiniopsis lenticularis (Rogers).
Lucina aquiana Clark.
Cucullaea gigantea Conrad.

All of these species, except *Cucullaea gigantea*, are confined to the Aquia stage.

[1] See the discussion of this form in the chapter on Systematic Paleontology, p. 156.

The following species of the Aquia stage, on the other hand, have not been found below the Upper Chickasawan, viz.:

Fusus interstriatus Heilprin.
Lucina uhleri Clark.
Modiolus alabamensis Aldrich.
Pecten choctavensis Aldrich.
Pteria limula (Conrad).

Of these, *Pteria limula* also occurs in the Claibornian. The Aquia stage also contains several species that have not been found below the Claibornian in the Gulf. They are:

Mesalia obruta (Conrad).
(?) *Odostomia trapaquara* (Harris).
Corbula oniscus Conrad.

The following species occur in the Jacksonian, viz.:

Cadulus abruptus Meyer and Aldrich.
Corbula oniscus Conrad.
Pecten dalli Clark.
Ostrea (*Gyphaeostrea*) *vomer* (Morton).

None of them is of special significance.

Before final conclusions are drawn from these comparisons, however, the fact must be taken into consideration that the Maryland beds have probably been examined at the present time more thoroughly and at a greater number of localities within the same limited area than those of the Gulf, and that some of the forms above mentioned may be shown upon further study to have a wider range in the Gulf than has been given to them. Due allowance must also be made for differences in judgment in the identification of species. At the same time, it is very clear that the species common to the Gulf and Middle Atlantic Slope differ materially in their geological range. This is evidently due in part to the difference in physical conditions in the two areas and also in part to migration. But after taking these facts into consideration it will be seen that the fauna of the Aquia is much more closely related to the Chickasawan as a whole than to either the Midwayan or Claibornian and that there is a somewhat closer resemblance to the Lower than to the Upper Chickasawan. The distance, however, between the two areas, the difference in physical conditions and the possibilities of migration are too great to admit of any attempt to draw exact parallelism between the substages.

Nanjemoy Stage.—The Nanjemoy stage contains the following species found in the Lower Chickasawan of the Gulf, all but one of which (*Cucullaea gigantea*) also range on upward into the Upper Chickasawan or higher stages. They are:

Tornatellaea bella Conrad.
Volutilithes petrosus (Conrad).
Levifusus trabeatus Conrad.
Cypraea smithi Aldrich.
Calyptraphorus trinodiferus Conrad.
Lunatia marylandica Conrad.
Calyptraea aperta (Solander).
Cadulus abruptus Meyer and Aldrich.
Corbula subengonata Dall.
Corbula aldrichi Meyer.
Meretrix ovata (Conrad.)
Pecten johnsoni Clark.
Glycymeris idoneus (Conrad).
Cucullaea gigantea Conrad.
Leda parva (Rogers).

The Nanjemoy stage contains the following species found in the Upper Chickasawan of the Gulf. They are:

Tornatellaea bella Conrad.
Volutilithes petrosus (Conrad).
Fusus interstriatus Heilprin.
Levifusus trabeatus Conrad.
Cypraea smithi Aldrich.
Calyptraphorus trinodiferus Conrad.
Lunatia marylandica Conrad.
Calyptraea aperta (Solander).
Cadulus abruptus Meyer and Aldrich.
(?) *Corbula subengonata* Dall.
Corbula aldrichi Meyer.
Meretrix ovata Conrad.
Meretrix subimpressa Conrad.
Lucina astartiformis Aldrich.
Lucina uhleri Clark.
Modiolus alabamensis Aldrich.
Pecten choctavensis Aldrich.
(?) *Pecten johnsoni* Clark.
(?) *Ostrea sellaeformis* Conrad.
Pteria limula (Conrad).
Glycymeris idoneus (Conrad).
Trigonoarca decisa (Conrad).
Leda parva (Rogers).
Leda potomacensis Clark and Martin.

Among these species a few only are restricted to the Upper Chickasawan. They are:

Fusus interstriatus Heilprin.
Meretrix subimpressa Conrad.
Lucina astartiformis Aldrich.
Lucina uhleri Clark.
Modiolus alabamensis Aldrich.
Pecten choctavensis Aldrich.
Leda potomacensis Clark and Martin.

Of these forms *Meretrix subimpressa, Lucina astartiformis* and *Leda potomacensis* are found only in the Nanjemoy stage.

The following species of the Nanjemoy stage are found in the Lower Claibornian:

Volutilithes petrosus (Conrad).
Levifusus trabeatus Conrad.
Pyrula penita var Conrad.
Mesalia obruta (Conrad).
Lunatia marylandica Conrad.
Calyptraea aperta (Solander).
Cadulus abruptus Meyer and Aldrich.
(?) *Corbula subengonata* Dall.
Corbula aldrichi Meyer.
Corbula oniscus Conrad.
Ostrea sellaeformis Conrad.
Pteria limula (Conrad).
(?) *Glycymeris idoneus* (Conrad).
Trigonoarca decisa (Conrad).

Among these forms *Mesalia obruta* is the only species that is confined to the Lower Claibornian, while three others do not pass the limits of the Claibornian stage, viz., *Pyrula penita var., Corbula oniscus* and (?) *Ostrea sellaeformis.*

FIG. 1.—POPES CREEK BLUFF SHOWING ZONE 17 OVERLAIN BY MIOCENE DIATOMACEOUS EARTH.

FIG. 2.—RAILROAD CUT NEAR UPPER MARLBORO SHOWING NANJEMOY FORMATION OVERLAIN BY LATER DEPOSITS.

VIEWS OF EOCENE SECTIONS.

Of the list above given, *Levifusus trabeatus, Pyrula penita var., Ostrea sellaeformis* and *Trigonoarca decisa* are confined to the Nanjemoy stage.

The following Nanjemoy species have been found in the Upper Clai-bornian:

Pyrula penita var. Conrad.	*Corbula oniscus* Conrad.
Lunatia marylandica Conrad.	*Ostrea sellaeformis* Conrad.
Calyptraea aperta (Solander).	*Pteria limula* (Conrad).

None of these species are confined to the Upper Claibornian and two of them only, *Pyrula penita var.* and *Ostrea sellaeformis*, are distinctively Nanjemoy forms.

The following species occur in the Jacksonian, viz.:

Cadulus abruptus Meyer and Aldrich.	*Pecten dalli* Clark.
Corbula oniscus Conrad.	*Ostrea* (*Gyphaeostrea*) *vomer* (Morton).

None of them, however, has any special significance.

It is thus shown that the Nanjemoy has faunal relationships both with the Chickasawan (and especially with the Upper Chickasawan) and with the Lower Claibornian. But in the Nanjemoy the lack of parallelism in the succession of faunas between the Middle Atlantic and Gulf regions is even more noticeable than in the lower beds. The only conclusion which can be drawn is that the Nanjemoy of Maryland represents such portion of the Chickasawan as lies above that represented by the Aquia, while the occurrence of the highly characteristic species, *Ostrea sellaeformis*, in the Nanjemoy stage in Maryland, although not so numerously or typically represented as in the still higher strata in central and southern Virginia, points to the possible Lower Claibornian age of the highest beds of the Maryland Eocene.

Geological Criteria.

The lithological and stratigraphical characteristics of the Eocene deposits of the Middle Atlantic Slope afford some important criteria for the correlation of the strata. In the first place, the homogeneous nature of the materials, already referred to, is a significant feature, and indicates conditions undisturbed by important physical changes throughout the period of Eocene deposition. Again, the fact that the strata are so largely composed of secondary materials shows that the position of accumulation was in the vicinity of a coast reached by no large sediment-

bearing rivers, while at the same time, for the most part, sufficiently removed from the coast-line to be unaffected by shore conditions. It is further evident that these deposits, which are so largely glauconitic, were very slowly accumulated, as has been shown in the case of the formation of greensand upon the beds of existing seas.

When we compare these conditions of accumulation on the Middle Atlantic Slope with the conditions that prevailed in the Gulf region during Eocene time marked differences appear. In the latter area numerous rivers, draining the interior of the continent, discharged large quantities of material throughout much of the Eocene, making the deposits highly diversified. Instead of the greensands and greenish and black clays of the Middle Atlantic Slope, which no longer to any great extent characterize the strata, are found coarser beds of sand and clay, often partly calcareous, which give every indication of more rapid accumulation. To compare, therefore, the 200 to 300 feet of greensands and clays of the Middle Atlantic Slope with one or two subdivisions of hardly equal thickness in the Gulf region would scarcely be attempted, even upon geological grounds. The strata of the Middle Atlantic Slope must be represented in the Gulf by deposits many times their thickness.

The State Geological Survey of Alabama has estimated the total thickness of the Eocene beneath the Jacksonian at 1500 feet, 600 feet of this belonging to the Chickasawan and 450 feet to the Claibornian. The Lower Chickasawan is given a thickness of about 350 feet and the Upper Chickasawan a thickness of about 250 feet, the Bells Landing division of the former having a thickness of less than 150 feet. The paleontological evidence previously cited, combined with the geological data here presented, show the far greater thickness of the geologically contemporaneous deposits in the Gulf as compared with those of the Middle Atlantic States.

Furthermore the general relations of the strata, occurring as they do between the Cretaceous and Neocene along both the Atlantic and the Gulf coasts, give some indication of the continental movements to which each province was subjected. Although the movements may not have been absolutely contemporaneous, they nevertheless afford satisfactory

criteria for the broad correlation of the deposits, their more exact parallelism being determined on other and more definite grounds.

European Equivalents.

Several attempts have been made to correlate the deposits of the Middle Atlantic Slope with those of Europe. The earlier attempts in this direction are presented in the Historical Review. Most of the conclusions reached were based on very insufficient data, the faunas being inadequately studied and even the sequence of deposits not being in most instances fully understood; but even after Conrad[1] began his study of the Maryland Tertiaries and described more or less fully the rich faunas contained therein, his correlations were still based on very insufficient knowledge. As the result of his investigations, he correlated the Eocene deposits of Maryland with the London Clay of England and the *Calcaire Grossier* of France.

Lyell,[2] during his visit to America in 1841, examined somewhat hurriedly the Eocene deposits of the Middle Atlantic area, but attempted no detailed correlation, stating, however, that the Tertiary formations which he saw "agree well in their geological types with the Eocene and Miocene beds in England and France."

Heilprin,[3] in an important publication on United States Tertiary Geology, discusses the equivalency of the European and American Tertiary formations. In a chapter dealing with "A Comparison of the Tertiary Mollusca of the Southeastern United States and Western Europe in Relation to the Determination of Identical Forms," he refers to the species which Conrad, Lea and Meyer had regarded as analogous to European forms, and also discusses in detail all those species which he regards as the same or which have certain points of resemblance. Referring to the more important of these forms in an earlier portion of the same volume (p. 13) he says: "If such comparisons are of any value stratigraphically, we may fairly look upon the Maryland Eocene deposits—the

[1] Jour. Acad. Nat. Sci. Phila., vol. vi, 1830, pp. 205-217; Fossil Shells of the Tertiary, 1832, pp. iv, 9, 12, 13.

[2] Proc. Geol. Soc. London, vol. iv, 1845, pp. 563-564; Quart. Jour. Geol. Soc. London. vol. i, 1845, p. 429-430.

[3] Contributions to the Tertiary Geology and Paleontology of the United States, pp. 83-101.

Piscataway sands below, and the Marlborough rock above—as representing a horizon nearly equal to that of the Thanet sands of England and the Bracheux sands of the Paris basin, or of the British Bognor rock (London clay). In either case they would be near the base of the Eocene series."

Dr. Dall,[1] in a recent article on "A Table of the North American Tertiary Horizons, Correlated with one Another and with Those of Western Europe, with Annotations," correlates the Maryland formations with the Suessonian of Europe. As the writers of this report believe, however, that the Eocene of Maryland represents more than the lower Chickasawan of the Gulf, they would assign to the Maryland Eocene a somewhat wider range in the European Eocene. It seems highly probable that the Londonian and even the Parisian in part are also represented. The few identical species in the two areas have a wide range geologically, and are thus of little value for purposes of detailed correlation. Other species may ultimately be found in common, but more careful comparisons than have been made will be necessary to establish this fact. Until such investigations have been made the correlation of the deposits on the two sides of the Atlantic can be at best only provisional.

[1] 18th Ann. Rept. U. S. Geol. Survey, pt. ii, 1898, pp. 327-348.

SYSTEMATIC PALEONTOLOGY

EOCENE

VERTEBRATA.

Class REPTILIA.

Order CROCODILIA.

Suborder ENSUCHIA.

Family CROCODILIDAE.

Genus THECACHAMPSA (CROCODILUS) Cope.

THECACHAMPSA sp.

Plate X, Figs. 1, 2.

Description.—A very large vertebra, probably dorsal, gives evidence of an animal of considerable size. The anterior face is deeply concave, and the rounded posterior face marked by a deep pit. It is impossible to determine whether the vertebra belongs to any one of the species below described and which are based on the teeth and jaws alone, and it therefore seems undesirable to assign a specific name to it.

Occurrence.—AQUIA FORMATION. Liverpool Point.

Collection.—Maryland Geological Survey.

THECACHAMPSA SERICODON (?) Cope.

Plate X, Fig. 3.

Thecachampsa sericodon Cope, 1867. Proc. Acad. Nat. Sci. Phila., p. 143.

Thecachampsa sericodon Cope, 1869. Proc. Acad. Nat. Sci. Phila., p. 12; Amer. Nat., p. 91.

Thecachampsa sericodon Cope, 1871. Trans. Amer. Phil. Soc., vol. xlv, p. 64, pl. v, figs. 7 and 8. (Pages 1-104 appeared in 1869.)

Thecachampsa sericodon Cope, 1875. Proc. Acad. Nat. Sci. Phila., p. 363.

Description.—A long slender tooth with a strong root represents this or an allied species. The specimen is water-worn and it is impossible to determine its characters exactly.

Occurrence.—AQUIA FORMATION. Clifton Beach.

Collection.—Maryland Geological Survey.

Thecachampsa contusor Cope.

Plate X, Fig. 4.

Thecachampsa contusor Cope, 1867. Proc. Acad. Nat. Sci., Phila., p. 143.

Description.—This species was recognized by Cope as of doubtful value and he considered the forms placed here as possibly belonging to *T. antiqua.* A specimen in the collection has the characters assigned to *contusor* except that the section of the base is elliptical instead of rounded, and certainly does not belong to *antiqua,* so that it may be placed here provisionally.

Occurrence.—Aquia Formation. Aquia Creek.

Collection.—Maryland Geological Survey.

Thecachampsa marylandica Clark.

Plate X, Fig. 5.

Thecachampsa marylandica Clark, 1895. Johns Hopkins Univ. Circ., vol. xv, p. 4.
Thecachampsa marylandica Clark, 1896. Bull. 141, U. S. Geol. Survey p. 58, pl. vii, fig. 1.

Description.—The specimen is a fragment of the jaw, described as "moderately thick, the single complete and one partially preserved alveoli not far removed from one another. Teeth with elongate, slightly curved, conic crowns; basis circular, its diameter about one-third the length of the tooth; apex acute, circular; surface with fine prolongations and striations." Clark, 1895.

Dimension of the tooth 38 mm., diameter at base 12 mm.

Occurrence.—Aquia Formation. Clifton Beach, Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Coprolite.

Plate X, Fig. 6.

Coprolite Clark, 1895. Bull. 141, U. S. Geol. Survey, p. 60, pl. vii, fig. 4.

Description.—A reptilian coprolite of very perfect form. It is only one-half preserved. These coprolites are rather common in the formation.

Occurrence.—Aquia Formation. Clifton Beach.

Collection.—Johns Hopkins University.

Order TESTUDENATA.

Suborder CRYPTODIRA.

Family CHELONIIDAE.

Genus EUCLASTES Cope.

EUCLASTES (?) sp. Clark.

Plate X, Fig. 7.

Euclastes (?) *sp.* Clark, 1895. Johns Hopkins Univ. Circ., vol. xv, No. 4.
Euclastes (?) *sp.* Clark, 1896. Bull. 141, U. S. Geol. Survey, p. 59.

Description.—"Several fragments from the carapace of a large sea turtle were found at Clifton Beach, but they were not sufficiently well preserved to identify the genus with certainty. Fragments of the costals show that the surface was smooth and the edges of the plate more or less rounded. The shields were relatively thin." Clark, 1895.

Occurrence.—AQUIA FORMATION. Clifton Beach.

Collection.—Johns Hopkins University.

Suborder TRIONYCHIA.

Family TRIONYCHIDAE.

Genus TRIONYX Geoffroy.

TRIONYX VIRGINIANA Clark.

Plate XI, Figs. 1, 2.

Trionyx virginiana Clark, 1895. Johns Hopkins Univ. Circ., vol. xv, No. 4.
Trionyx virginiana Clark, 1896. Bull. 141, U. S. Geol. Survey, p. 59, pl. viii, figs. 1a and 1b.

Description.—Fragments of costals with tuberculated and ridged surfaces, characteristic of the genus *Trionyx*. The longitudinal ridges are prominent, at times irregular and inosculate; relatively remote and separated by intervals of about twice their width; generally entirely disappear near the margins of the plates.

Length of the largest fragment 130 mm., width 45 mm., thickness 18 mm.

This fragment is evidently one of the terminal costals with no projecting portion of the rib beyond the plate.

Occurrence.—Aquia Formation. Aquia Creek.

Collections.—Wagner Free Institute of Science, Johns Hopkins University, Maryland Geological Survey.

Class PISCES.

Order ELASMOBRANCHII.

Suborder TECTOSPONDYLI.

Family MYLIOBATIDAE.

Genus MYLIOBATIS Cuvier.

The following remarks on the crushing pavement-teeth of the great "Eagle-rays," so abundant in the American and European Eocene, are extracted from an important paper on sharks' teeth from the English Eocene by A. S. Woodward.[1]

"The dentition of each jaw in this genus [*Myliobatis*] comprises large, flattened, hexagonal teeth, arranged in seven antero-posterior series. In very young individuals, the teeth are all approximately of equal size, but quite early in life the median teeth begin to become relatively very broad, and as the animal grows, this disproportion of the median teeth gradually becomes greater and greater. When unworn or unabraded, the grinding surface of the teeth is covered with a thin enamel-like layer of gano-dentine, usually marked with antero-posteriorly directed striations; but when this layer is removed, the tooth has a punctate appearance, owing to the exposure of the vertical nutritive canals traversing the underlying vascular dentine. In naming the fossils, it is thus necessary to take into account the size of the specimen, and remember that the surface markings depend on the state of preservation. It is also necessary to note that the dental plate of the lower jaw is flat, while that of the upper jaw curves round the supporting cartilage."

[1] Proc. Geol. Assoc., vol. xvi, 1899, p. 3.

MYLIOBATIS COPEANUS Clark.

Plate XII, Figs. 1, 2; Plate XIII, Figs. 2a, 2b, 6, 7a, 7b.

Myliobatis copeanus Clark, 1895. Johns Hopkins Univ. Circ., vol. xv, p. 4.
Myliobatis copeanus Clark, 1896. Bull. 141, U. S. Geol. Survey, p. 61, pl. vii, figs. 3*a*, 3*b*.

Description.—Dentition large and massive, the coronal contour strongly curved antero-posteriorly, and moderately arched from side to side in the upper jaw, but only very slightly so in the lower. Transverse sutures strongly and regularly concave toward the front in upper median teeth, less so in those of lower jaw, where they are sometimes slightly serrated. Upper median teeth relatively longer than the lower, but often variable in this respect; as a rule they are about five times as broad as they are long in the adult. Lateral teeth long and narrow, arranged parallel with the main axis. Surface smooth and polished when unabraded, but becoming longitudinally striated and fissured when worn. Oral surface of lower dental plate exhibiting a slight longitudinal depression along the central portion, and under surface correspondingly thickened, the latter having an arcuate contour from side to side.

This species is very abundant in the Eocene of Maryland and Virginia, but is apparently unknown beyond the limits of these states. A large series of specimens has been collected, thus facilitating a comparison of successive growth stages, and of variations due to wear and other causes. It is a remarkably massive form, the thickness of the median teeth equalling that of *M. pachyodon* from the Miocene, and the transverse section being very much the same. In the latter species, however, the transverse sutures of the median teeth are nearly straight, being only slightly curved backward at the extremities, whereas the present form is distinguished by the median sutures being uniformly concave toward the front. The curvature of the suture-lines is usually more pronounced in the upper dentition than in the lower, and in the newest-formed teeth than in those more anteriorly situated. The median teeth of the lower dental plate are also somewhat shorter, as a rule, than those in the upper jaw, and the coronal contour is much less arched from side to side.

Dental pavements are not uncommon showing as many as nine longitudinal series of median teeth intact (Plate XIII, Figs. 6, 7). One of the largest upper dental plates examined is from the Aquia Formation of Potomac Creek, and in this the median teeth are 6.5 cm. wide, 1.5 cm. long, and 3 cm. thick, not including the root. The antero-posterior curvature of the coronal surface is so great as to form a nearly perfect semicircle, having a diameter of 8 cm. and a periphery of over 12 cm. Nine of the median teeth are preserved in regular series, together with a portion of the lateral series on both sides. There is considerable resemblance between this species and *M. holmesii* from the Eocene of South Carolina.

The type consists of fragmentary dental plates of the upper and lower jaws.

Occurrence.—Nanjemoy Formation. Woodstock. Aquia Formation. Clifton Beach, Liverpool Point, Aquia Creek, Potomac Creek.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Myliobatis magister Leidy.

Plate XII, Fig. 3; Plate XIII, Figs. 1a, 1b.

Myliobatis magister Leidy, 1876. Proc. Acad. Nat. Sci. Phila., p. 86.

Myliobatis magister Leidy, 1877. Jour. Acad. Nat. Sci. Phila., N. S., vol. viii, p. 233, pl. xxxiii, fig. 7.

Myliobatis holmesii Woodward, 1899. Cat. Foss. Fishes, Brit. Mus., pt. i, p. 122.

Description.—Dentition very large and massive, the median teeth at least six times wider than long, their sutures curved backward near the lateral margins, and sometimes very faintly so in the central area. Coronal contour of upper dental plate uniformly arched from side to side, and also to an equal extent in a longitudinal direction; lower dental plate less curved antero-posteriorly than the upper, and slightly depressed along the median line. Surface smooth when unworn, or with fine superficial striæ slightly convergent toward the front.

This gigantic species, which is exceeded in size only by the Egyptian *M. pentoni*, is not actually known to occur in Maryland, being confined, so far as known, to the Eocene Phosphate Beds of South Carolina. It is noticed in this connection, however, because of the interest attached

to the original, which is the largest specimen hitherto reported from this country. The figured specimen was found at Ashley, South Carolina, and is preserved in the Museum of Comparative Zoology at Cambridge, Massachusetts. The strong curvature of the oral surface, which is equal in both longitudinal and transverse directions, together with the proportions and wavy sutures of the median teeth prove it beyond all doubt to be the upper dentition, previously unknown, of a species founded by Leidy on a unique lower dental plate from the same locality, to which he applied the name *M. magister*. Leidy himself, and following him A. S. Woodward, were of the opinion that the type-specimen might represent the lower dentition of *M. holmesii* Gibbes, which was described from a supposed upper dental plate with strongly curved sutures. The specimen in the Cambridge collection, however, completes our knowledge of the dentition of *M. magister*, and we must look elsewhere for the opposing dentition of Gibbes' species. The latter, as has already been intimated, appears to be only very slightly different from *M. copeanus* of this state.

The type consists of a lower dental plate.

Collections.—Philadelphia Academy of Natural Sciences, Museum of Comparative Zoology, Cambridge.

Genus AETOBATIS Müller and Henle.

In this genus there is but a single series of very broad, flat teeth, those of the upper jaw only differing from the median teeth of *Myliobatis* in their truncated lateral ends. The lower dentition is very nearly flat, and the teeth are all more or less strongly curved or angularly bent in the middle. The coronal surface is smooth or slightly striated, and the attached surface of the root longitudinally ridged or grooved. Woodward[1] remarks that "In this genus there is much less variability in the relations of the length and breadth of the teeth according to age than in *Myliobatis;* but the form of the lower teeth is so inconstant, that species cannot be determined upon the evidence of the lower dentition alone."

[1] *Cat. Foss. Fishes, British Museum*, pt. i, 1889, p. 128.

Aetobatis arcuatus Agassiz.

Plate XIII, Figs. 3a, 3b, 8.

Aetobatis arcuatus Agassiz, 1843. Poiss. Foss., vol. iii, p. 327.
Aetobatis arcuatus Cope, 1867. Proc. Acad. Nat. Sci. Phila., p. 139.
Aetobatis profundus Cope, 1867. *Loc. cit.*, p. 139.
Aetobatis arcuatus Leidy, 1877. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. viii, p. 245, pl. xxxi, figs. 14-18.
Aetobatis profundus Leidy, 1877. *Loc. cit.*, p. 246, pl. xxxi, figs. 19, 20.

Description.—This species is known only by fragments belonging chiefly to the lower dentition, and consequently cannot be accurately defined. Founded originally on detached teeth from the Miocene of Switzerland, it has been recognized by Cope and Leidy from the corresponding horizon in Maryland, but has not been hitherto reported from the Eocene. It would appear to be very rare in the latter formation, as only a few detached teeth have been collected by the Maryland Geological Survey. A number of Miocene forms from Charles county are figured by Leidy (*loc. cit.*, 1877, pl. xxxi), who very plausibly suggests that the narrow rounded crowns described by Cope as *A. profundus* are in reality only worn anterior teeth belonging to the species under consideration. Other species of *Aetobatis* occur in the Eocene of New Jersey and South Carolina.

Occurrence.—Nanjemoy Formation. Popes Creek. Aquia Formation. Aquia Creek.

Collection.—Maryland Geological Survey.

Suborder ASTEROSPONDYLI.

Family CESTRACIONTIDAE.

Genus SYNECHODUS Woodward.

This genus of Cestraciont sharks is known by the nearly complete dentition and parts of the skeleton in the Lias of England, where it accompanies such allied forms as *Hybodus*, *Acrodus*, etc., and detached teeth have also been described from the Cretaceo-Tertiary of New Zealand. Its remains have not been heretofore reported, however, from strata of undoubted Tertiary age, and the following species may be regarded as the latest survivor of the genus of which we have any record.

Synechodus clarkii n. sp.

Plate XIV, Figs. 5a, 5b, 5c.

Description.—Teeth of small or moderate size, but of relatively stout proportions, and symmetrical. Median cone sharply recurved, gently tapering, smooth, convex on both faces, and cutting edges not conspicuously defined; on either side, two much smaller cones, the external one being the lesser of the two. Root massive and somewhat turgid, produced in the arc of a circle on the inner face, and flat below; nutrient foramen small.

The total height of the tooth, oriented in its natural position, is 7 mm. The distance from apex to base of crown, measured along its recurved outer face, is 6 mm. The width and thickness of the crown at its base are equal, amounting to 3 mm., whereas the corresponding measurements of the root, taken at their maximum, are 8 mm. and 4 mm. respectively.

This unique tooth appears sufficiently well characterized, notwithstanding that the lateral cones are broken off above the base, to warrant recognition as a distinct species, and it may be fittingly named in honor of the State Geologist. Much interest is attached to the fact of its coming from a Tertiary horizon.

Occurrence.—Aquia Formation. Liverpool Point.

Collection.—Maryland Geological Survey.

Family LAMNIDAE.

Genus ODONTASPIS Agassiz.

The teeth of this genus are very similar to those of the Cretaceous *Scapanorhynchus*, a survivor of which has been recognized in *Mitsikurina* of the present day; and they are also, as remarked by Agassiz, very difficult to distinguish from those of *Lamna*. The crown is high, narrow and compressed in all except a few hindermost teeth, and adjacent to it are one or two pairs of lateral denticles, generally sharply pointed. The anterior teeth are especially high-crowned, comparatively large and slender, with a much produced bifurcated root.

Odontaspis elegans (Agassiz).

Plate XIV, Figs. 2a, 2b, 2c, 3a, 3b, 3c.

Lamna elegans Agassiz, 1843. Poiss. Foss., vol. iii, p. 369, pl. xl*b*, fig. 24.

Lamna elegans Gibbes, 1849. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 196, pl. xxv, figs. 98-102 (? figs. 96, 97).

Lamna elegans Emmons, 1858. Rept. Geol. Surv. N. Car., p. 239, figs. 70, 71.

Lamna elegans Noetling, 1885. Abh. Geol. Specialk. Preussen u. Thüring. Staaten, vol. vi, pt. 3, p. 61, pl. iv.

Odontaspis elegans Woodward, 1889. Cat. Foss. Fishes, British Mus., pt. i, p. 361.

Odontaspis elegans Clark, 1895. Johns Hopkins Univ. Circ., vol. xv, p. 4.

Odontaspis elegans Clark, 1896. Bull. 141, U. S. Geol. Survey, p. 62.

Odontaspis elegans Woodward, 1899. Proc. Geol. Assoc., vol. xvi, p. 8, pl. i, figs. 15-18.

Description.—Anterior teeth with a very high and narrow crown, only slightly curved, the inner face strongly striated longitudinally, and scarcely flattened in the middle. A single pair of small, prickle-like lateral denticles, and nutritive foramen on the prominent inner side of the root placed in a deep cleft. Lateral teeth with an almost equally slender, but less elevated crown, which is similarly striated and flanked with relatively large, slender denticles. The two branches of the root are long, compressed and generally pointed.

This is the most abundant of all Eocene sharks' teeth in Maryland and Virginia, but is of rare occurrence in the Miocene. It is a somewhat smaller form than *O. macrota*, and the anterior teeth of the two species are so much alike that it is difficult to separate them. This is especially true of worn specimens (Plate XIV, Fig. 2) where the denticles are wanting and the striation of the inner face inconspicuous,[1] and chief reliance must be placed on the narrowness of the crown. The anterior teeth sometimes exceed 4 cm. in total height. Dr. F. Noetling, and following him, Jaekel and Smith Woodward, have been chiefly instrumental in reconstructing the dentition of this and other species of Odontaspis.

The type consists of teeth and associated vertebrae in the museum of College of Surgeons, London.

Occurrence.—Aquia Formation. Aquia Creek, Fort Washington, Liverpool Point.

Collections.—Johns Hopkins University, Maryland Geological Survey.

[1] On the striation of Selachian teeth, see J. Probst, *Wurtt.*, *Jahresb.*, vol. xv, 1859, p. 100.

Odontaspis macrota (Agassiz).

Plate XIV, Figs. 4a, 4b.

Otodus macrotus Agassiz, 1843. Poiss. Foss., vol. iii, p. 273, pl. xxxii, figs. 29-31.

Lamna elegans Agassiz, 1843. *Tom. cit.*, p. 289, pl. xxv, figs. 1-7; pl. xxxvii*a*, figs. 58, 59.

Lamna compressa Agassiz, 1843. *Tom. cit.*, p. 290, pl. xxxvii*a*, figs. 35-42.

Lamna compressa Gibbes, 1849. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 197, pl. xxv, figs. 107-112.

Otodus macrotus Gibbes, 1849. *Tom. cit.*, p. 200, pl. xxvi, figs. 2, 143, 144.

Lamna compressa Emmons, 1858. Rept. Geol. Surv. N. Car., p. 240, figs. 72, 75, 76.

Odontaspis macrota O. Jaekel, 1895. Mém. Comité Géol., St. Petersb., vol. ix, pp. 11, 29, pl. i, figs. 8-17.

Odontaspis macrota Woodward, 1899. Proc. Geol. Assoc., vol. xvi, p. 9, pl. i, figs. 19, 20.

Description.—Anterior teeth much compressed, the inner face with fainter, more wavy and more interrupted striæ than those of *O. elegans.* Typical lateral teeth much compressed, crown with sharp cutting edges and a faintly striated inner face; outer coronal face gently convex. A single pair of large and broad lateral denticles, usually rounded, but sometimes obtusely pointed.

This species is tolerably abundant in the Eocene of various localities in Maryland and Virginia, especially at Liverpool Point on the Potomac river. The lateral teeth rarely exceed 2.5 cm. nor the anterior 3.5 cm. in total height.

Occurrence.—Nanjemoy Formation. Woodstock. Aquia Formation. Aquia Creek, Fort Washington, Liverpool Point.

Collection.—Maryland Geological Survey.

Odontaspis cuspidata (Agassiz).

Plate XIV, Figs. 1a, 1b, 6a, 6b.

Lamna cuspidata Agassiz, 1843. Poiss. Foss., vol. iii, p. 290, pl. xxxvii*a*, figs. 43-50.

Lamna cuspidata Gibbes, 1849. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 197, pl. xxv, figs. 103-106.

Lamna clavata Agassiz, 1856. Rept. Pac. R. R. Explor. and Surv., vol. v, p. 316, pl. i, figs. 19-21.

Lamna clavata Agassiz, 1856. Amer. Jour. Sci., ser. ii, vol. xxi, p. 275.

Odontaspis hopei Noetling, 1885. Abh. Geol. Specialk., Preussen u. Thüring, Staaten, vol. vi, pt. 3, p. 71, pl. v, figs. 1-3.

Odontaspis cuspidata Woodward, 1899. Proc. Geol. Assoc., vol. xvi, p. 7, pl. i, figs. 12-14.

Description.—Teeth scarcely distinguishable from those of *O. elegans* except by their slightly smaller size and by the absence of striæ upon the inner coronal face. Anterior teeth much elevated and narrow, but moderately stout. Lateral denticles of both anterior and lateral teeth occasionally flanked by a smaller secondary pair.

Teeth belonging to this species accompany those of *O. elegans* and *O. macrota* in various localities of Maryland and Virginia, but are less numerous than either of these forms. From the Miocene of this state, very few examples have been obtained. In some specimens two well-developed pairs of lateral denticles occur, as shown in Plate XIV, Fig. 1, and also in Figs. 86*a* and 87*a* of Emmon's North Carolina Geological Survey Report (1858), p. 241.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock. Aquia Formation. Mattawoman Creek, Fort Washington, Liverpool Point.

Collection.—Maryland Geological Survey.

Genus OTODUS Agassiz.

Nearly all the species assigned by Agassiz to this genus have been distributed by subsequent authors among *Lamna, Odontaspis* and *Oxyrhina.* Noetling even goes so far as to refer the type-species *O. obliquus,* to the genus *Carcharodon,* although the coronal margin is never distinctly serrated. The best modern opinion is that the peculiarly robust teeth belonging to this species should be provisionally retained in the place provided for it by its founder, and along with this should be ranged a second, somewhat smaller species occurring in England and Russia, known as *O. trigonalis* (Jaekel).

Otodus obliquus Agassiz.

Plate XV, Figs. 1-4c.

Otodus obliquus Agassiz, 1843. Poiss. Foss., vol. iii, p. 267, pl. xxxi, pl. xxxvi, figs. 22-27.

Otodus obliquus Gibbes, 1849. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 199, pl. xxvi, figs. 131-137.

Lamna acuminata Gibbes, 1849. *Loc. cit.*, p. 197, pl. xxv, figs. 113, 114 (? *not* fig. 115).

Lamna (?) *obliqua* Clark, 1895. Johns Hopkins Univ. Circ., vol. xv, p. 4.

Lamna (?) *obliqua* Clark, 1896. Bull. 141, U. S. Geol. Survey, p. 61.

Otodus obliquus Woodward, 1899. Proc. Geol. Assoc., vol. xvi, p. 10.

Description.—"Teeth robust, attaining to a very large size; crown moderately compressed, sharply pointed, with one broad acuminate pair of lateral denticles, and, in the smaller teeth, an additional pair of more slender denticles. Outer coronal face flat or slightly convex, without folds; inner face smooth. Inner face of the root prominent, and nutritive foramen not sunk in a groove." Agassiz, 1843.

These very robust teeth attain a large size, the crown sometimes measuring 5 cm. in height (cf. Plate XV, Fig. 4), but the majority of specimens do not exceed 3 cm. in total height. The anterior teeth (Plate XV, Fig. 1) are narrow and erect, with rather deeply cleft root, and frequently with only one or no lateral denticles; they are sometimes difficult to distinguish from the anterior teeth of *Odontaspis macrota.* The lateral teeth are distinguished by their broader, more compressed and usually obliquely directed crowns. The small hindermost teeth are often extremely broad-based, but here as elesewhere in the jaws, much individual variation occurs. It does not appear possible, however, to recognize more than a single species in the American Tertiaries. Numerous examples are found in the Eocene of Maryland, Virginia, New Jersey, and the Carolinas.

Occurrence.—Aquia Formation. Liverpool, Aquia Creek, Glymont.

Collections.—Maryland Geologieal Survey, Johns Hopkins University.

Genus CARCHARODON Agassiz.

The teeth of *Carcharodon* attain enormous size, exceeding those of all other Selachian genera. They are triangular, usually erect, and resemble those of *Oxyrhina* and *Otodus* except that the edges of the compressed crown are always serrated. Some species are without lateral denticles, others have a single pair, serrated like the crown. The genus enjoyed a world-wide distribution during the Eocene and Miocene, and was exceedingly abundant in various localities of both hemispheres. In the South Carolina Phosphate Beds the teeth are so numerous as to be of no mean commercial importance.

CARCHARODON AURICULATUS (Blainville).

Squalus auriculatus Blainville, 1818. Nouv. Dict. d'Hist. Nat., vol. xxvii, p. 384.
Carcharodon acutidens Gibbes, 1847. Proc. Acad. Nat. Sci. Phila., p. 267.
Carcharodon angustidens Gibbes, 1848. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 145, pl. XIX, figs. 10-18, pl. XX, pl. XXI, figs. 37-38.
Carcharodon acutidens Gibbes, 1848. *Tom. cit.*, p. 146, pl. xxi, figs. 39-41.
Carcharodon rectus Agassiz, 1856. Rept. Pac. R. R. Explor. and Surv., vol. v, p. 316, pl. i, figs. 39-41.
Carcharodon rectus Agassiz, 1856. Amer. Jour. Sci., ser. ii, vol. xxi, p. 274.
Carcharodon crassidens Emmons, 1858. Rept. Geol. Surv. N. Car., p. 233, fig. 59*a*.
Carcharodon contortidens Emmons, 1858. *Loc. cit.*, p. 233, fig. 60.
Carcharodon angustidens Leidy, 1877. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. viii, p. 253.
Carcharodon angustidens Noetling, 1885, Abh. Geol. Specialk., Preussen u. Thür. Staaten, vol. vi, pt. 3, p. 82, pl. vi, figs. 1-3.

Description.—"Teeth robust, comparatively narrow, with a pair of broad lateral denticles; outer coronal face flat or slightly convex. Lateral denticles especially large in the lateral teeth, which have a very narrow oblique crown." Blainville, 1818.

This species is apparently very rare in the Maryland Tertiaries, only a single fragmentary example having been obtained from the Eocene of Popes Creek, and very few from the Miocene. Owing to its imperfection, no figure is given of the Eocene tooth, but it is to be noted that the lateral denticles are very feebly developed, so that the reference to this species is not absolutely certain.

Occurrence.—NANJEMOY FORMATION. Popes Creek.

Collection.—Maryland Geological Survey.

Family CARCHARIIDAE.

The teeth of this family of "man-eating sharks" are very abundant in the Tertiary of all countries, and closely resemble those of the LAMNIDAE. They differ from the latter however, in their internal structure, being hollow in the center throughout life, and with minute tubules radiating from the pulp-cavity across the dentine. The teeth are so much alike in existing genera that when found in the detached fossil condition it is often impossible to separate them. For instance, the upper teeth of *Hypoprion* are scarcely distinguishable from those of *Galeus*, and isolated teeth of *Galeocerdo* and *Sphyrna* are difficult to distinguish from those of *Carcharias*. It is rather surprising that the last-

named genus does not appear to be present in the Maryland Eocene, and the teeth of *Galeocerdo contortus*, although very abundant in the corresponding horizons of Virginia and South Carolina, are likewise wanting in this state. *Hemipristis serra* is another common form in the Carolina Eocene, and also in the Miocene of the Atlantic Slope extending as far north as Gay Head, Massachusetts, but is apparently unknown in the Eocene of Maryland and Virginia.

Genus GALEOCERDO Müller and Henle.

The teeth of this genus are serrated on both margins, have the posterior edge deeply notched, and the apex more or less sharply inclined backward. As already remarked, some species are very difficult to distinguish from *Carcharias*, and in the case of the teeth referred to *G. minor* by Gibbes, Emmons and Cope, comparisons show that these really belong to species of *Carcharias*.

Galeocerdo latidens Agassiz.

Plate XIV, Fig. 8.

Galeocerdo latidens Agassiz, 1843. Poiss. Foss., vol. iii, p. 231, pl. xxvi, figs. 22, 23 (? figs. 20, 21).

Galeocerdo latidens Gibbes, 1849. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 192, pl. xxv, figs. 59–62.

Description.—"Teeth broad, mostly low-crowned, the largest measuring about .024 cm. across the base. Anterior coronal margin only slightly arched, except near the apex; apex above the posterior notch small, narrow; margin below the posterior notch long, straight and much inclined; root large. Serrations of the coronal margin very prominent."

This species is not uncommon in the Maryland Miocene, but as yet only a single example has been obtained from the Eocene of this state. Its preservation is not so good as might be desired, and it is rather under the average size attained by this species.

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Maryland Geological Survey.

Genus SPHYRNA Rafinesque.

The small teeth belonging to this genus are similar in both jaws, oblique, with a slight posterior notch, and margins smooth or serrated. Their resemblance to the teeth of *Carcharias* has already been noted.

SPHYRNA PRISCA Agassiz.

Plate XIV, Figs. 7a, 7b.

Sphyrna prisca Agassiz, 1843. Poiss. Foss., vol. iii, p. 234, pl. xxvi*a*, figs. 35-50.
Sphyrna prisca Gibbes, 1849. Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 194, pl. xxv, figs. 88-90.
Lamna compressa (*pars*) Emmons, 1858. Rept. Geol. Surv. N. Car., p. 240, figs. 79-81.
(?) *Sphyrna denticulata* Emmons, 1858. *Loc. cit.*, p. 241, fig. 84*a*.

Description.—Teeth small, broad, gently oblique, often erect, with finely serrated edges.

This species is very abundant in the Eocene of South Carolina and Miocene of Maryland, but only two or three rather imperfect examples have been obtained from the Eocene of this state. There was also found one doubtful tooth, which may possibly belong to a distinct species.

Occurrence.—AQUIA FORMATION. Liverpool Point.

Collection.—Maryland Geological Survey.

SELACHIAN VERTEBRAE.

Detached vertebrae of the Asterospondylic type, consisting of calcified cartilage and therefore not well adapted for preservation, are occasionally met with in the Eocene of Clifton Beach and a few other localities in Maryland and Virginia. Some of the larger ones are but slightly concave on both faces, and belong without doubt among the LAMNIDAE, possibly to *Otodus* or *Carcharodon*. Detached vertebrae of both Elasmobranch and Teleost fishes are much more common in the Miocene than Eocene, and represent a considerable variety of forms. In Plate XII, Figs. 7*a* and 7*b* are represented detached vertebrae of an indeterminate species of bony fishes.

SUBCLASS TELEOSTOMI.

Order ACTINOPTERYGII.

Remains of bony fishes are very rare in the Tertiary of the Middle Atlantic Slope, and are confined to detached vertebrae, otolites and portions of the dentition. A few species founded on detached teeth from

the Eocene of South Carolina have been described by Leidy,[1] and a singular bone from the same horizon supposed to belong to *Platax* is figured by Gibbes.[2] Cope records in all only one species of Actinopterygians from the Miocene of Maryland (*Sphyraena speciosa*), and five from the same horizon in New Jersey, as follows: *Sphyraena speciosa*, *S. siloviana*, *Phasganodus gentryi*, *Crommyodus irregularis*, and *Phyllodus curvidens*.[3] The last-named genus is of exceptionally rare occurrence in the American Tertiary, being known only by the four detached dental plates noticed by Wyman[4] and by Marsh.[5] The peculiar teeth first described by Leidy from the Cretaceous of New Jersey under the name of *Ischyrhiza*, occur also in the Miocene of Maryland and North Carolina, if we may credit the statements of Cope[6]; and according to this author certain coalesced caudal vertebrae ("hypural fans") accompanying the Cretaceous teeth and occurring also in the Eocene of Maryland and South Carolina should be referred to this genus, which he claims is related to the *Esocidae*. It is much more likely, however, that the Cretaceous fans belong to *Protosphyraena* or some similar form, and that the Tertiary fans, which all agree in having the terminal centrum attached, belong to one or more species of Sword-fishes.

Genus XIPHIAS Linnaeus.

Fragmentary remains of Sword-fishes have been met with from time to time in various Tertiary horizons, but in most cases are insufficient for accurate identification. Detached rostra and hypural fans of large size, both probably belonging to *Xiphias* or some related genus, are not uncommon in the Eocene of South Carolina. A number of such remains, including the types of *X. robustus* Leidy, are preserved in the Holmes Collection belonging to the American Museum of Natural History in New York. Here also is to be seen the tooth of *Ischyrhiza mira* figured by Leidy in Holmes' *Post-Pleiocene Fossils of South Carolina* (Plate XXV, Figs. 3, 4), which is the most perfect specimen of that

[1] Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. viii, 1877, pp. 254-257, pl. xxxiv.

[2] *Ibid.*, vol. i, 1849, p. 300, pl. xlii, figs. 10-13.

[3] Proc. Amer. Philos. Soc., vol. xiv, 1875, p. 362.

[4] Amer. Jour. Sci., ser. ii, vol. x, 1850, p. 234.

[5] Proc. Amer. Assoc. Adv. Sci., 18th Meet., 1870, p. 228.

[6] Vertebrata Cret. Form. West, Rept. U. S. Geol. Surv. Territ., vol. ii, 1875, p. 280.

form extant. The Tertiary caudal fans which have been theoretically associated with the teeth of *Ischyrhiza* by Cope and Clark are here considered to belong to typical Sword-fishes. The following species is the only one known to occur in Maryland.

XIPHIAS (?) RADIATA (Clark).

Plate XII, Fig. 8.

Ischyrhiza (?) *radiata* Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.

Ischyrhiza (?) *radiata* Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 60, pl. vii, fig. 2*a* (? *non* figs. 2*b*, 2*c*).

Description.—Terminal vertebral centrum deeply concave in front and circular in cross-section, its neural and haemal spines fused into a solid fan-shaped body; the anterior haemal spine less completely fused with the next following than are all the rest, and even separated from it near the point of attachment with the centrum by a small perforation passing completely through the fan. [Dentition and other parts of the skeleton unknown.]

This species is established on a unique fan-shaped body, the extreme height of which is 3.9 cm.; but some of the South Carolina specimens exceed 10 cm. The latter also differ from the Maryland form in having the vertebral centrum transversely elongated instead of circular.

The type is a hypural fan in the Museum of Johns Hopkins University.

Occurrence.—AQUIA FORMATION. Clifton Beach.

Collection.—Johns Hopkins University.

Genus PHYLLODUS Agassiz.

The presence of this interesting genus in North America was first made known by Dr. Jeffries Wyman,[1] who came into possession of two unique dental plates from the Eocene of Richmond, Virginia. Rather poorly executed woodcuts of both specimens are given by him, the more perfect one being compared with *P. toliapicus* Agassiz, and the other declared to be different from any described species. This paper of Wyman's seems to have escaped general notice, and was certainly overlooked by Marsh,[2] when in 1870 he claimed his *P. elegans* and *P. curvi-*

[1] Amer. Jour. Sci., ser. ii, vol. x, 1850, p. 234.

[2] Proc. Amer. Assoc. Adv. Sci., 18th Meet., 1870, p. 228.

dens, likewise founded on unique dental plates from the Eocene and Miocene respectively of New Jersey, to be the first indications of this genus in North America. Neither of the last two species have been figured, but it is probable from Marsh's brief description that *P. elegans* is a young example of *P. toliapicus*. Furthermore, it is practically certain that neither of Wyman's specimens are referable to *P. toliapicus*, but each is representative of a distinct species. Whether their horizon is Eocene or Miocene was not conclusively determined by Wyman, although the chances are in favor of attributing them to the former. Traces of this genus have not as yet been discovered in Maryland, but the following species deserves notice on account of its historical and scientific interest.

PHYLLODUS HIPPARIONYX n. sp.

Phyllodus sp. aff. *toliapicus* Wyman, 1850, Amer. Jour. Sci., ser. ii, vol. x, p. 234, woodc. fig. 9*a*.

Type.—Detached dental plate; formerly in Museum of Comparative Zoology, Cambridge, Mass.

OTOLITES.

Plate XII, Figs. 4-6.

Fish otolites, or "ear-stones," are found almost exclusively in the detached condition, this being due to the fact that they are held in place during life only by membranes, and hence readily fall out from the head and sink to the bottom while the decomposing body of the fish continues to float on the surface, a prey to all sorts of creatures, or is cast ashore by the waves. The circumstance of large numbers of fossil fish skeletons being found in close proximity to one another, but none of them having otolites preserved *in situ*, is cited as an argument against their having met their death suddenly or in shoals. The peculiar structure and composition of otolites favor their preservation in the fossil state, hence it is not surprising that they should occur in considerable abundance and variety throughout the Tertiary and even older horizons. Rather is it the converse proposition which excites wonder; for when we consider the number of forms represented solely by ear-bones, it is difficult to understand why not a vestige of other parts of the skeleton remains.

The otolites of Cyclostomes and cartilaginous fishes consist of irregular and loosely united aggregations of lime carbonate; those of Teleostomes, on the other hand, are dense porcellanous bodies composed of microscopic crystals of calcite, excellently adapted for fossilization. The proportion of calcite frequently amounts to 98 per cent of the whole, and the organic matter rarely exceeds 4 per cent. Although extremely variable in form and size, nothing can be predicated from these characters as to the proportions of the complete fish. The sculpturing of the external surface, however, has been found fairly distinctive for certain families; for instance, it is more or less tuberculose among the GADIDAE, SCIAENIDAE, etc., and radially folded among the PERCIDAE and SPARIDAE.

Otolites are secreted in a few definite regions of the auditory apparatus. A small one, termed by Koken the *lapillus*, is formed in a portion of the labyrinth known as the "vestibule" or *utriculus*; another (*asteriscus* of Koken) occurs in the posterior prolongation of the otolite-sac (*sacculus*), and the principal ear-stone in the center of the sac proper. The principal otolite (*sagitta* of Koken) occupies a constant position with reference to the investing sacculus, partaking of its shape and being attached to its inner wall; and accordingly it is capable of being precisely oriented, even when found in the detached fossil condition. That is to say, a dorsal and ventral, anterior and posterior, and inner and outer side are almost always to be recognized, as well as the side of the head to which it belongs. But on the other hand the configuration, and in the opinion of some excellent authorities, even the surface markings of fish otolites are dependent on the variable form of the enclosing membranous sac, and are by no means constant within specific or even generic limits.[1]

[1] "Hasse hält auch die Form der Otolithen für unwichtig, als ein mit der Form des Sacculus sich auderndes Moment. . . . Die Gestalt der Otolithen ist allerdings in gewissen Grenzen variabel, in Zusammenhange mit den individuellen Schwankungen der Sacculus-Form, welcher sie sich anpasst. Auch ist das Wachsthum vorwiegend auf die äussere Seite angewiesen, welche frei im Sacculus liegt; . . . . dementsprechend ist das Wachsthum der äusseren Seite unregelmässiger, und gerade die auf die Sculptur derselben sich gründenden Merkmale . . . erwiesen sich öfters als ungeeignet, weil sie sich durch Vergrösserung des Gehörsteines zu leicht verwischen."—E. Koken, Ueber Fisch-Otolithen etc. (*Zeitschr. d. d. geol. Ges.*, vol. xxxvi, 1884, p. 518).

Nevertheless, the structure and topography of these minute and apparently insignificant bodies have been investigated with great care, and a precise nomenclature established. For the depression extending from the anterior margin backward in a horizontal direction on the flat or concave inner side, Koken has proposed the designation of *sulcus acusticus*, and this he regards as furnishing the most important diagnostic characters. The sculpture of the inner and outer sides, and nature of the peripheral border, whether sharp or thickened, smooth, folded, denticulated or incised, and various minor characters of like nature are all taken into account in the attempt to identify detached specimens. Their size, too, is held to be an important distinguishing character.

The most painstaking investigations on fossil otolites from both our own and European Tertiaries are those of Professor Koken,[1] and reference should be had to his writings by all interested in this subject. A summary of the earlier literature is given by him in the first paper cited below. If any are inclined to question the accuracy of his determinations of genera and species, the opportunity is certainly open for more extended comparisons with recent and fossil forms.

Otolites occur rather frequently in the Eocene of Maryland, but only a few have been found in the Miocene at Plum Point. A few typical examples are shown in Plate XII, Figs. 4-6, but further than to say that they bear a general resemblance to those of the GADIDAE, their identification is not attempted here.

Occurrence.—NANJEMOY FORMATION. Port Tobacco, 2½ miles above Popes Creek, Woodstock.

Collection.—Maryland Geological Survey.

COPROLITES.

Rolled cylindrical bodies of amorphous structure and very suggestive of fossil fish excrement are occasionally found at a few localities in the Eocene of Maryland and Virginia. The occurrence of coprolites of enormous size in the Miocene of Virginia has been known for a long time.[2]

[1] *Loc. cit.*, pp. 500–565.—Neue Untersuchungen an tertiären Fisch-Otolithen, *ibid.*, vol. xl, 1888, pp. 274–305.

[2] Wyman, Notice of Remains of Vertebrated Animals found at Richmond, Virginia, Amer. Jour. Sci., ser. ii, vol. x, 1850, p. 235.

ARTHROPODA.

Class CRUSTACEA.

Superorder MALACOSTRACA.

Order DECAPODA.

Family CANCROIDEA.

Description.—Claws belonging to an indeterminate genus of the Cancroidea are abundant in the bed underlying the indurated ledge at Upper Marlboro.

All of the specimens are so fragmentary that no attempt is made to illustrate the forms.

Collection.—Maryland Geological Survey.

Superorder OSTRACODA.

Family BAIRDIIDAE.

Genus BYTHOCYPRIS Brady.

BYTHOCYPRIS SUBAEQUATA n. sp.

Plate XVI, Figs. 1-4.

Description.—Carapace about 1.0 mm. in length, elongate, subcylindrical or, perhaps better, subreniform, the dorsal outline arcuate, the ventral slightly hollowed, and the ends rounded and nearly equal, the posterior a trifle blunter than the anterior; end view nearly circular, dorsal and ventral views lanceolate, with the greatest thickness about the middle of the posterior half; left valve slightly overlapping the right along its ventral edge; surface smooth or very finely granulose. Inner side of valves with simple thin edges, and within these, except along the dorsal border, a thin bevelled plate, much the widest anteriorly.

There are numerous fossil and recent Ostracoda, mostly of otherwise widely diverging genera, that have a carapace similar to this, but none was found exactly matching it.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Bythocypris parilis n. sp.

Plate XVI, Figs. 5-8.

Description.—Carapace about 1.0 mm. long, and nearly or quite 0.5 mm. high; reniform, strongly arched dorsally, very slightly sinuate or straight in the ventral portion of the outline, and with the ends rounded and very nearly equal, the posterior outline however being usually a trifle oblique above, and the turn into the basal line slightly lower than at the front end; point of greatest thickness above the middle, the slope toward the ventral edge being flatter than elsewhere; edge view elongate, subelliptical, the anterior extremity more acute than the posterior, the latter being comparatively blunt. Left valve slightly overlapping the right both above and below, its ventral edge somewhat thickened in the middle and bordered along the anterior and posterior thirds of its extent by a sharply impressed, thin line. Surface generally appearing quite smooth, but under favorable circumstances very small scattered punctae may be observed. Interior of valves with the marginal plate well developed and widest in front.

This carapace is relatively higher, has a more arcuate back, and less acute anterior extremity (in edge view) than its associate *B. subaequata.* It is distinguished further by the dorsal overlap of the valves and in the greater development of the internal marginal plate.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family CYTHERELLIDAE.

Genus CYTHERELLA Jones.

Cytherella marlboroensis n. sp.

Plate XVI, Figs. 9-13.

Description.—Carapace nearly regularly ovate, the height and length about as two is to three; 0.9 or 1.0 mm. in length; ventral portion of outline somewhat less convex than the dorsal. Right valve much larger than the left and projecting beyond it all around. Edge view obtusely lanceolate, with both extremities blunt, the posterior, the more so, and

much thicker than the other; end view subovate. Valves comparatively thin for this genus, the marginal groove of the right valve relatively narrow though sharply defined. Interior of right valve with two subovate smooth spaces, situated one in the anterior, the other in the posterior half, and around them concentric rows of small pustules. Surface smooth or minutely punctate.

No known Tertiary species agrees very closely with this. The well-known *C. compressa* (Münster), has a similar edge view, as have also several other species, but otherwise, the form of its carapace, especially the ventral portion of the outline, is quite different. The Cretaceous *C. ovata* is probably a closer relative but differs obviously in its edge and end views.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Cytherella submarginata n. sp.

Plate XVI, Figs. 14, 15.

Description.—Carapace about 1.0 mm. in length, somewhat oblong, rounded at the ends, the posterior end a little wider and its margin more oblique above and merging more gradually into the very slightly arcuate dorsal outline than the anterior; ventral margin straight, edge view subcuneiform, end view subovate. Valves compressed convex, thickest posteriorly, with an obscurely defined broad depression near the midlength and mostly above the center of the valves. A narrow but distinct rim borders the two ends. Surface smooth.

Of this species only the single valve figured has been seen. Compared with described species it was found to agree rather well with *C. londinensis* Jones a Lower Eocene species from London, Eng., but after a closer examination it was decided that it could not be justly referred to that species. As described and figured *C. londinensis* must have quite a different appearance in edge views, due to the more uniform convexity of its valves. The central depression and marginal rims as well as its different outline, will serve to distinguish *C. submarginata* at once from *C. marlboroensis* with which it is associated.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family CYTHERIDAE.

Genus CYTHERE Müller.

Cythere marylandica n. sp.

Plate XVI, Figs. 16-18.

Description.—Carapace about 1.0 mm. in length and 0.55 mm. in height and thickness, subovate in outline; hinge straight, half the entire length of carapace, ventral outline broadly arcuate; anterior end obliquely rounded, most prominent in the lower half and much wider than the posterior end; the latter is neatly rounded below, obtusely angular above the middle, then straight or slightly sinuate to the subangular extremity of the hinge line. Valves unequal, the left overlapping the right, very convex and swollen in the middle and thickest near the ventral edge. The swollen region of the valves is of subtriangular shape and sharply defined where it rises from the relatively small, compressed, terminal remnants of the surface. Of these remnants the posterior is more depressed (it may appear like a flattened border) and narrower than the anterior one, and both are marked with shallow pits arranged in rather obscure concentric series. The surface of the swollen region is more distinctly pitted, with the pits arranged in the lower half between more or less sharp longitudinal curved riblets and much less regularly in the upper half. Sometimes the swelling is terminated below by one or two ribs more prominent and stronger than the rest. Edge view subovate, with the ends produced; end view subtriangular with the lateral lines rather strongly convex. Hingement consists as usual in *Cythere* of large lateral teeth and connecting bar.

This seems to be a well-marked species with not very close relations to *C. trigonula* Jones and *C. triangularis* (Reuss) Jones. From both it differs in outline, the former, varying further in, having also a finer surface punctation, a much more triangular end view, and relatively very slightly compressed ends causing the edge view to be equally different. *C. triangularis* agrees better in end and edge views but its surface differs decidedly, being "smooth, shining, and beset with scattered setae." Another of the species described by Jones in his Monograph of the Tertiary Entomostraea of England, especially since he mentions that he has a scarcely distinguishable variety of it from the middle Ter-

tiary of Maryland, may be compared with *C. marylandica*. This is *Cythere punctata* (Münster). Judging from illustrations alone the present species must be quite distinct and so obviously that it seems highly improbable that the American variety of Münster's species mentioned by Jones, is the same as the one above described.

Occurrence.—Aquia Formation. Upper Marlboro, Brooks Estate near Seat Pleasant.

Collection.—Maryland Geological Survey.

Genus CYTHEREIS Jones.

Cythereis bassleri n. sp.

Plate XVI, Figs. 19-21.

Description.—Carapace oblong, length 0.80 to 0.85 mm., widest and rounded anteriorly; the posterior edge more or less angular in the middle, straight or slightly sinuate above to the angular extremity of the hinge, and with two or three spines projecting from the slightly convex, lower half; edges with a thickened rounded rim, becoming obsolete near the center of the flattened ventral region; hinge line straight except at the antero-cardinal angle which is thickened and prominent; ventral outline slightly sinuate. Valves equal, with a rounded sub-central node, sometimes obscured by a network of small ridges, and a sharp ventral ridge rising gradually from its inception at the antero-ventral angle and ceasing abruptly at a point about one-fourth of the length of the valve from its posterior extremity. A less prominent ridge runs from the high end of the ventral ridge in a slightly oblique direction to the post-cardinal angle and then turns forward. The whole surface is covered with rather large pits arranged in more or less irregular curved series, the space between the rows, especially over the central portion of the valves being raised into thin and sometimes coalescing ridges.

This species presents more or less close affinities with no less than six of the species of *Cythere* figured by Bosquet in his excellent Monograph of the Ostracoda of the Tertiary deposits of France.[1] These are *C. hebertiana* Bosq., *C. thierensiana* Bosq., *C. deshayesiana* Bosq., *C.*

[1] Desc. des Entomostrace's Fossiles des Terrains Tertiaires de la France et de la Belgique. Mem. Couron. Acad. Belg., Tome xxiv, 1851.

angusticostata Bosq., *C. macropora* Bosq. and *C. edwardsi* (Roemer), all Eocene species except the last, which is a widely distributed Miocene fossil. Despite the often striking similarities presented, not one of the European species mentioned agrees closely enough in *all respects* to justify a reference of the Maryland form to it.

Cythereis bassleri, which I name in honor of my able and indefatigable assistant, Mr. R. S. Bassler, seems to be a common fossil at Upper Marlboro. Considering that the specimens studied present considerable variation in surface sculpture, it is possible that they represent more than a single specific type. I have also a specimen from the Cretaceous at Vincentown, N. J., which can scarcely be distinguished from the Upper Marlboro specimen figured.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Genus CYTHERIDEA Bosquet.

Cytheridea perarcuata n. sp.

Plate XVI, Fig. 22, 23.

Description.—Carapace 1.1 mm. long, 0.6 mm. high, strongly and, excepting the acuminate posterior extremity, rather uniformly convex, obliquely acute-ovate in outline; ventral edge straight to the acute posterior extremity, the sharpness of which is emphasized by a small spine; anterior outline wide and regularly rounded, and armed with five or six spines; dorsal side strongly arcuate, the curve straightening somewhat as it nears the posterior end. Central portion of surface, over a space corresponding in shape with the outline of the valves, marked with eleven or twelve approximately vertical furrows, each including a row of small punctures. Beyond this space the surface is smooth, excepting toward the posterior end where an obscurely wrinkled appearance may be observed. Ventral edge of right valve with a narrow bevel inward. Hinge as required by the genus, consisting of a series of small denticles at each end of the hinge in right valve and corresponding sockets in the left valve. Edge view broadly lanceolate, thickest near the middle length and slightly more attenuate behind than in front; end view subcircular.

At first it was believed that this form might be regarded as a variety of *Cytheridea mülleri* (Münster), a common and widely distributed European Tertiary and Recent species. However a more careful comparison brought out so many differences that it seemed best to rank them as distinct species. This conclusion was confirmed by finding almost unquestionable *C. mülleri* associated with *C. perarcuata* at Woodstock, while *C. intermedia* (Reuss) which Jones considers a close variety of *C. mülleri,* was found rather abundantly in association with specimens agreeing closely with Jones' *C. debilis,* at Upper Marlboro. *C. perarcuata* differs from all of these forms in the restricted extent of its surface markings, in wanting a mesial furrow, in its relatively greater height and more strongly arcuate dorsal outline. Its edge view furthermore is decidedly different, the central portion being thicker, while the ends, the posterior especially, are thinner.

Occurrence.—Nanjemoy Formation. Woodstock. Aquia Formation. Potomac Creek.

Collection.—Maryland Geological Survey.

MOLLUSCA.

Class CEPHALOPODA.

Subclass TETRABRANCHIATA.

Order NAUTILOIDEA.

Suborder ORTHOCHAENITES.

Family CLYDONAUTILIDAE.

Genus HERCOGLOSSA Conrad.

Hercoglossa tuomeyi n. sp.

Plates XVII-XIX.

Nautilus sp. Tuomey, 1842, Amer. Jour. Sci., vol. xliii, p. 187.
Nautilus sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Nautilus sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 63, pl. ix, fig. 1.

Description.—Shell large; aperture wide, narrowing rapidly, without curving to a narrow and sharply rounded periphery; ventral saddles of

moderate size; lateral lobes regularly but moderately rounded; lateral saddles narrower and sharper than the other saddles; umbilici not small; shell thick (2-8 mm.), marked by fine, distinct, closely-set lines of growth, which sweep sharply back on the periphery.

This species is distinguished from *H.* (*Enclimatoceras*) *ulrichi* by its much less prominent ventral saddles, and by its less uniformly rounded transverse section, the sides being almost without curvature down almost to the very periphery.

The nautiloid shell which Tuomey roughly described without naming was from the James river and from a horizon exactly corresponding to our Popes Creek occurrence. There is little doubt that it was this species.

Diameter (restored) of coil of largest specimen about 400 mm.

Occurrence.—Nanjemoy Formation. Popes Creek (abundant). Aquia Formation. Clifton Beach (fragments rare).

Collections.—Maryland Geological Survey, Johns Hopkins University.

Class GASTROPODA.

Order OPISTHOBRANCHIATA.

Suborder TECTIBRANCHIATA.

Family ACTAEONIDAE.

Genus TORNATELLAEA Conrad.

Tornatellaea bella Conrad.

Plate XX, Figs. 1, 1a, 2.

Tornatellaea bella Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. iv, p. 294, pl. xlvii, fig. 23.

Tornatella bella Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.

Tornatella bella Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 63.

Description.—"Ovate, spire conical; revolving lines numerous, impressed, punctate striate." Conrad, 1860.

Shell solid, ovate in profile, six-whorled; surface with uniform, punctate, spiral grooves, crossed only by lines of growth and regularly un-

dulating in width; spire short, conical, acuminate; whorls slightly convex; body whorl more than half the length of the shell, moderately convex; suture distinct; outer lip sometimes crenulate; columella with two pronounced oblique plicae.

Length, 15 mm.; width, 8 mm.

Occurrence.—Nanjemoy Formation. West of Port Tobacco. Woodstock, 1 mile southeast of Piscataway. Aquia Formation. Aquia Creek, Potomac Creek, 1 mile northeast of Piscataway, Upper Marlboro.

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences, U. S. National Museum.

Family RINGICULIDAE.

Genus RINGICULA Deshayes.

Ringicula dalli Clark.

Plate XX, Figs. 3, 3a.

Ringicula dalli Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Ringicula dalli Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 64, pl. ix, figs. 3*a*, 3*b*.
Ringicula dalli Aldrich, 1897, Bull. Amer. Pal. No. 8, p. 8, pl. ii, fig. 6.

Description.—" Shell small, five-whorled; surface of last four whorls strongly striate spirally; spire elevated, acuminate; body whorl much inflated; outer lip much thickened and crenulate within; columella with thick callous and with two strong plaits." Clark, 1896.

Length, 3 mm.; width, 2 mm.

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Maryland Geological Survey.

Family SCAPHANDRIDAE.

Genus CYLICHNA Lovén.

Cylichna venusta Clark.

Plate XX, Figs. 4, 4a.

Cylichna venusta Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Cylichna venusta Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 64, pl. ix, figs. 2*a*, 2*b*.

Description.—" Shell small, elongate-ovate, rather globose; surface spirally striate; spire depressed; columella with small obscure plait." Clark, 1896.

The spire is usually perforate, and the revolving lines alternate and punctate. It most closely resembles *C. aldrichi* Langdon, from which it is distinguished by being proportionally longer, less cylindrical in outline, and with the spire less strongly perforate.

Length, 7 mm.; width, 3.5 mm.

Occurrence.—NANJEMOY FORMATION. West of Port Tobacco, Head of Nanjemoy Creek, Woodstock. AQUIA FORMATION. 1 mile southeast of Mason Springs, Potomac Creek, 2 miles below Potomac Creek, 1 mile northeast of Piscataway, Clifton Beach.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Superfamily TOXOGLOSSA.

Family PLEUROTOMIDAE.

Genus PLEUROTOMA Lamarck.

PLEUROTOMA HARRISI Clark.

Plate XX, Figs. 5, 5a, 6.

Pleurotoma harrisi Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Pleurotoma harrisi Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 64, pl. ix, figs. 4*a*, 4*b*.

Description.—"Shell of moderate size, elongate, five or six whorled; surface with distinct, revolving lines of varying size, crossed by transverse ridges; aperture narrow, with long straight canal." Clark, 1896.

The lower half of the whorl is strongly convex and is strongly ornamented with revolving lines, alternating in size, and is crossed on the shoulder by oblique nodular ridges. The upper half of the whorl is flat, with very faint revolving lines, except one or two strong ones about the middle of the flat zone. The aperture narrows rapidly toward the base, the body whorl partaking of the constriction. The canal is very long, straight, and narrow.

Length, 30 mm.; width, 8 mm.

Occurrence.—AQUIA FORMATION. Potomac Creek, 2 miles below Potomac Creek, 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Pleurotoma potomacensis n. sp.

Plate XX, Figs. 7, 7a.

Description.—Shell attenuate, with spire and beak of equal length; aperture narrow; beak long and straight; whorls seven, with four more in the nucleus; few large, raised, revolving lines on and below the shoulders; numerous fine, proximate lines between these, and covering the entire whorl; two prominent, raised, revolving lines below the suture, the lower more prominent; shoulder with acute nodes, carinated by one or two of the major revolving lines; lines of growth faint.

Some varieties of *P. nasuta* Whitfield are very similar to this species. It is intermediate between that species and *P. harrisi* Clark.

Length, 31 mm.; width, 8 mm.

Occurrence.—Aquia Formation. 1 mile northeast of Piscataway, 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Pleurotoma ducateli n. sp.

Plate XX, Fig. 8.

Description.—Surface smooth, save for faint, impressed, revolving lines which become stronger just below the suture, and very strong on the beak; suture very distinct; columella straight, striated spirally; lines of growth faint, with broad sinus below the suture.

Length, 10 mm.; width, 4 mm.

Occurrence.—Aquia Formation. 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Pleurotoma tysoni n. sp.

Plate XX, Fig. 9.

Description.—Shell eight-whorled; body whorl about half the length of shell; mouth contracting but slightly toward beak; body whorl with sixteen, oblique, longitudinal ribs, strongly nodular where crossed by the large, elevated, revolving lines; eight strong, revolving lines on the body whorl below the shoulder, and numerous fainter ones below, on the beak. All the whorls are concave above the shoulder, and unsculptured, save for lines of growth and for a strong, raised, nodular, subsutural

line. Whorls of the spire with four nodular revolving lines below the shoulder.

Length, 12 mm.; width, 4 mm.

Occurrence.—Aquia Formation. 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Subgenus HEMIPLEUROTOMA Cossmann.

Pleurotoma (Hemipleurotoma) childreni Lea.

Plate XX, Figs. 10, 11.

Pleurotoma childreni Lea, 1833, Contrib. to Geol., p. 137, pl. iv, fig. 132.
Pleurotoma denticula var Harris, 1899, Bull. Amer. Pal., No. 11, p. 12, pl. i, figs. 21, 22.

Description.—" Shell fusiform, turrited, transversely striate, granulate on the larger part of the whorl; substance of the shell rather thick; spire elevated, obtuse at apex; whorls about nine, subcanaliculate above; mouth long and narrow, one-third the length of the shell." Lea, 1833.

Our specimens vary considerably in the smaller details of sculpture, but all seem to fall within the limits of variation of the Alabama form. Whether they are the same as the French species *P. denticula* Bast. to which Professor Harris assigns the Alabama form is a question that cannot be settled here. They agree with it well enough to fall into the subgenus *Hemipleurotoma* of which *P. denticula* is the type.

Length, 12 mm.; width, 3.5 mm.

Occurrence.—Aquia Formation. 1 mile southeast of Mason Springs, 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Pleurotoma piscatavensis n. sp.

Plate XX, Fig. 12.

Description.—Shell fusiform, seven-whorled, carinated; lines of growth distinct; revolving lines absent above the shoulder, one to three in number below the shoulder; beak marked only by lines of growth; nucleus three-whorled, smooth; following whorls of the spire with oblique plicae, extending from suture to suture; body whorl with about ten acute nodes, confined to the suture.

Length, 11 mm.; width, 4 mm.

Occurrence.—Aquia Formation. 1 mile northeast of Piscataway.

Collection.—Maryland Geological Survey.

Genus MANGILIA Risso.

Subgenus PLEUROTOMELLA Verrill.

Mangilia (Pleurotomella) bellistriata Clark.

Plate XX, Figs. 13, 13a.

Mangilia (Pleurotomella) bellistriata Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.

Mangilia (Pleurotomella) bellistriata Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 65, pl. ix, fig. 5.

Description.—" Shell small, subfusiform, with a rather short, pointed spire, and about five whorls; body whorl large, somewhat inflated; earlier whorls nearly flat; surface sculptured with numerous, alternating, larger and smaller spiral threads, crossed by fine, wavy lines, and by irregularly spaced, oblique ribs, about twenty in number on the body whorl; ribs strongest at the shoulder, gradually disappearing both posteriorly and anteriorly; behind the shoulder somewhat excavated; aperture narrow." Clark, 1896.

There is a distinct fold on the columella, and the lines of growth are very slightly curved.

Length, 27 mm. (restored); width, 13 mm.

Occurrence.—Nanjemoy Formation. Popes Creek. Aquia Formation. Potomac Creek.

Collections.—Johns Hopkins University, Philadelphia Academy of Natural Sciences.

Family CANCELLARIDAE.

Genus CANCELLARIA Lamarck.

Cancellaria graciloides Aldrich, var.

Plate XXI, Fig. 1.

Cancellaria graciloides Aldrich, 1898, The Nautilus, vol. xi, p. 98.

Cancellaria graciloides Harris, 1899, Bull. Amer. Pal., No. 11, pp. 28, 29, pl. iii, figs. 10, 11.

Description.—" Shell broadly fusiform, spire elevated, whorls 6-7, rounded, slightly shouldered, cancellated, first three smooth, on the

others the revolving lines are numerous, strongly defined; lines of growth smaller and much finer than the revolving lines, suture deeply impressed, outer lip expanded, strongly nodular within, columella with three folds, aperture pointed and canaliculate at base." Aldrich, 1898.

This abundant and variable form approaches too near to some varieties of *C. graciloides* to be safely separated from it.

Length, 13 mm.; width, 8 mm.

Occurrence.—AQUIA FORMATION. 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

CANCELLARIA sp.

Plate XXI, Fig. 2.

Several specimens of Cancellaria were found that are so imperfect and immature, that it is unsafe to describe them or even to refer them to any known species, yet they are very different from our other Maryland species.

The figured specimen represents a form from the locality two miles below Potomac Creek which also doubtfully occurs at Potomac Creek, and which distantly recalls *C. parva* Lea.[1] When the adult is found it will probably be recognized as a new species.

Another form from Potomac Creek may be *C. ulmula* Harris[2] or a variety. This is so imperfect that it does not seem desirable to figure it.

Occurrence.—AQUIA FORMATION. 2 miles below Potomac Creek, Potomac Creek.

Collection.—Maryland Geological Survey.

Subgenus NARONA H. and A. Adams.

CANCELLARIA (NARONA) POTOMACENSIS n. sp.

Plate XXI, Figs, 3, 3a.

Description.—Shell elongate; mouth more than half the length of the shell; spire short; whorls marked with distinct, raised, flat-topped, revolving ridges, with interspaces twice as broad; body whorl with twenty of these ridges, whorls of the spire with six. Lines of growth and

[1] Contrib. Geol., p. 42, pl. v, fig. 141.

[2] Proc. Acad. Nat. Sci. Phila., vol. xlvii, 1895, p. 66, pl. vi, fig. 6.

several variable, usually obscure, longitudinal undulations cross the revolving ribs, granulating them and often reticulating the surface. Labium expanded, grooved and cancellated. Labium with two, distinct, oblique folds and numerous striae, continuations of the external revolving lines. Canal short, recurved.

Length, 17 mm.; width, 8 mm.

Occurrence.—Aquia Formation. 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Superfamily RACHIGLOSSA.

Family OLIVIDAE.

Genus OLIVULA Harris.

Olivula sp.

A single specimen was found which gives little doubt of its generic character. It is probably distinct from *O. staminea* (Conrad). In the imperfect condition of the specimen it is impossible to assign it to any species, new or old, and a figure would show no determining characters.

Length, 20 mm.; width, 6 mm.

Occurrence.—Nanjemoy Formation. Popes Creek.

Collection.—Maryland Geological Survey.

Family VOLUTIDAE.

Genus VOLUTILITHES Swainson.

Volutilithes petrosus (Conrad).

Plate XXI, Figs. 4, 5, 5a.

Voluta petrosa Conrad, 1833, Fossil Shells of the Tertiary, No. 3 [1st Edit.], p. 29.
Voluta petrosa Conrad, 1835, Fossil Shells of the Tertiary, No. 3 [2nd Edit.], p. 41, pl. xvi, fig. 2.
Athleta tuomeyi Conrad, 1853, Proc. Acad. Nat. Sci. Phila., vol. vi, p. 449.
Volutilithes (Athleta) tuomeyi Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Volutilithes (Athleta) tuomeyi Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 65, pl. x, figs. 1*a*, 1*b*.

Description.—"Shell subglabrous; body whorl marked with from eight to ten longitudinal folds, terminating on the shoulder in compressed

subacute tubercles, which are also distinct on the spire: transversely striated at base: two folds on the columella." Conrad, 1833.

The Maryland specimens are principally of the *tuomeyi* type, but the normal form occurs with it at most localities.

Length, 38 mm.; width, 25 mm.

Occurrence.—Nanjemoy Formation. Woodstock, Popes Creek, West of Port Tobacco. Aquia Formation. Potomac Creek, 2 miles below Potomac Creek, 1 mile northeast of Piscataway, 1 mile southeast of Mason Springs, Aquia Creek.

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences, U. S. National Museum.

Volutilithes sp.

Plate XXI, Figs. 6, 6a.

Volutilithes sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Volutilithes sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 65, pl. x, figs. *2a*, *2b*.

A fine cast of a large species of *Volutilithes* was obtained from the indurated ledge, Zone 3, at the Aquia Creek bluffs, and a very imperfect specimen from Potomac Creek. It is unlike any of the species of *Volutilithes* hitherto described, but from the fact that the shell substance is almost lacking no attempt will be made to give a full description. It has a somewhat compressed form, due to pressure.

The shell substance is extremely thin, and the surface is marked only by lines of growth. The tubercles are obtuse and distant, and the spire small.

Length, 75 mm.; width, 53 mm.

Occurrence.—Aquia Formation. Aquia Creek, Potomac Creek.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Genus CARICELLA Conrad.

Caricella pyruloides (?) (Conrad).

Plate XXI, Figs. 7, 8.

Turbinella pyruloides Conrad, 1833, Fossil Shells of the Tertiary, No. 2, p. 24, pl. x, fig. 1.
(?) *Caricella sp.* Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
(?) *Caricella sp.* Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 66, pl. xi, fig. 1.

Description.—"Pyriform, ventricose, smooth; with obscure spiral striae on the inferior half of the body whorl; spire very short; apex slightly mammillated; columella with 4 distant oblique plaits." Conrad, 1833.

The specimens which are referred to this species consist of the cast and the broken shell which are figured, and a still more imperfect cast. It is not certain that they belong to the same species, or that any of them belong to the species to which they are here referred. If they do not belong here they probably represent one or more undescribed species.

Length, 55 mm.; width, 22 mm.

Occurrence.—Aquia Formation. Potomac Creek, Aquia Creek, Liverpool Point.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Genus MITRA Lamarck.

Mitra marylandica Clark.

Plate XXI, Figs. 9, 9a.

Mitra marylandica Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Mitra marylandica Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 66, pl. xi, figs. *4a*, *4b* (not 3).

Description.—"Shell small, rather thick, with six (?) whorls; surface with numerous, thickly-set spiral threads, crossed by fine wavy lines, giving a finely reticulated appearance; spine moderately high; suture distinct, appressed; shoulder not prominent; aperture elongated; columella nearly straight, with three plaits." Clark, 1896.

The essential character which distinguishes this species from the following is the lack of ribbing.

Length, 21 mm.; width, 7 mm.

Occurrence.—Aquia Formation. Pomonkey Neck.

Collection.—U. S. National Museum.

Mitra pomonkensis n. sp.

Plate XXI, Figs. 10, 10a.

Mitra sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Mitra sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 66, pl. xi, figs. *3a*, *3b*.

Description.—Shell larger than *M. marylandica;* whorls strongly convex, and with a somewhat angulated shoulder slightly above the middle;

sculptured by numerous, approximate, impressed, revolving lines, and variable longitudinal ribs, which stop at the shoulder, leaving a subsutural constriction above it.

The best specimens of this species are in the Philadelphia Academy and are from Potomac Creek.

The type in the U. S. National Museum is now labelled "'*Near Mouth of Potomac Cr.,' G. D. Harris,*" but it was supposed when described to have come from Pomonkey Neck.

Length, 25 mm.; width, 9 mm. The largest specimen has width of 12 mm.

Occurrence.—Aquia Formation. Pomonkey Neck, 2 miles below Potomac Creek, Potomac Creek, 1 mile northeast of Piscataway.

Collections.—Maryland Geological Survey, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Mitra potomacensis n. sp.

Plate XXI, Fig. 11.

Description.—Shell small; whorls but slightly convex, and not constricted below the suture; revolving lines fine, distinct; ribs reaching from suture to suture, and often extending in one continuous line from whorl to whorl; ribs usually sharp and narrow.

Length, 12 mm.; width, 3.5 mm.

Occurrence.—Nanjemoy Formation. Woodstock, Popes Creek. Aquia Formation. 1 mile northeast of Piscataway.

Collection.—Maryland Geological Survey.

Family FUSIDAE.

Genus LATIRUS Montfort.

Latirus marylandicus n. sp.

Plate XXI, Figs. 12, 12a.

Description.—Shell subfusiform, five or more whorled; body whorl with fifteen, blunt, irregular, longitudinal folds, and a number of revolving ridges, very prominent on the shoulder and gradually dying out toward the beak; entire shell covered by fine, closely-set, raised, revolv-

ing threads, which over-ride both the longitudinal and the revolving folds, the threads showing a tendency to alternate in size; whorls of spire with two, very distinct, revolving folds; major intersecting sets of sculpture giving a reticulate appearance; folds strongly nodular at the intersections; mouth narrow; columella with two, strong, oblique folds; canal long and straight.

Length, 26 mm.; width, 11 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Genus FUSUS (?) Lamarck.

The following species are referred to the genus *Fusus* without any claim that their biological affinities are with that genus as now restricted. They belong to that large group of fossils, of approximately fusoid form, but indeterminate generic relationships.

Fusus (?) subtenuis Heilprin.

Plate XXII, Figs. 1, 2.

Fusus subtenuis Heilprin, 1880, Proc. Acad. Nat. Sci. Phila., vol. xxxv, p. 371, pl. xx, fig. 4.

Description.—"Shell fusiform, of about seven subangular volutions; whorls ornamented with somewhat obscure longitudinal folds, about twelve on the body whorl, which are cut by several prominent revolving ridges commencing at the shoulder angulation; shoulder of the whorls more or less smooth, with an obscure median revolving line, and a prominent subsutural one; aperture about the length of the spire, or slightly exceeding it, the canal gently curved, moderately contracted, and somewhat expanding at the extremity; outer lip thin, and showing internally the external ornamentation; base with numerous revolving lines, which alternate in coarseness." Heilprin, 1880.

Very characteristic specimens of this species occur at the locality noted below.

Length, 35 mm. (restored); width, 18 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Fusus (?) interstriatus Heilprin.

Plate XXII, Figs. 4, 4a.

Fusus interstriatus Heilprin, 1880, Proc. Acad. Nat. Sci. Phila., vol. xxxv, pl. xx, fig. 11.

Description.—"Shell fusiform, slender, composed of about ten convex volutions, the first three of which are smooth; whorls ornamented with both longitudinal plications and revolving lines, the last of which (about eight in the upper whorls), alternate with finer intermediate striae; the longitudinal plications distinct on the earlier whorls, but becoming much less so on the body whorls, and the one preceding; aperture about the length of the spire; the canal somewhat tortuous; outer lip thin, dentate within." Heilprin, 1880.

The Maryland form differs from that from the Gulf states in that its ribs are alternate, while in the latter they are doubly alternate or with three smaller ones between each pair. The longitudinal plications may be either present or partly absent as on the Gulf form.

Length, 16 mm.; width, 6 mm.

Occurrence.—Nanjemoy Formation. Woodstock. Aquia Formation. 1 mile northeast of Piscataway, Aquia Creek.

Collection.—Maryland Geological Survey.

Family MURICIDEA.

Genus TROPHON Montfort.

Trophon sublevis Harris.

Plate XXII, Fig. 3.

Trophon sublevis Harris, 1899, Bull. Amer. Pal., No. 11, p. 61, pl. viii, figs. 1, 19.

Description.—"Size and general form as indicated by the figure; whorls seven, embryonic three smooth, spire and body whorl smooth, polished, but with nine sharp-edged costae on each whorl, becoming somewhat pointed on the shoulder; faint undulations indicating indistinct, distant spirals between the ribs; outer lip thickened, with five crenulations within, the upper the stronger; no umbilicus." Harris, 1899.

A single fragment was found which may safely be assumed to represent this species.

Length, 13 mm. (restored); width, 5 mm.

Occurrence.—Aquia Formation. 1 mile northeast of Piscataway.

Collection.—Maryland Geological Survey.

Family BUCCINIDAE.

Genus STREPSIDURA Swainson.

Strepsidura subscalarina Heilprin.

Plate XXII, Figs. 5, 6, 7, 8, 8a.

Fusus (Strepsidura) subscalarinus Heilprin, 1880, Proc. Acad. Nat. Sci. Phila., vol. xxxv, p. 372, pl. xx, fig. 8.

Fusus (Strepsidura) perlatus Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.

Fusus (Strepsidura) perlatus Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 67.

Description.—" Shell somewhat bucciniform, whorls about eight, subangular, the first three or four smooth, the remainder ornamented with both longitudinal costae and revolving striae, the latter showing a tendency to alternate in size; the costae are arcuate, not in a regularly continuous series, those of the body whorl extending considerably below the middle of the whorl; aperture about the length of spire, the canal somewhat reflected; columella covered with a callous deposit, considerably twisted; outer lip dentate within." Heilprin, 1880.

Our specimens show a marked tendency to variation both in shape and sculpture, as the figures show, but none of the forms seem to be sufficiently definite to warrant the separation of another species.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock. Aquia Formation. Liverpool Point, Potomac Creek, 2 miles below Potomac Creek, Upper Marlboro.

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences.

Genus MELONGENA Schumacher.

Melongena (?) potomacensis n. sp.

Plate XXII, Fig. 9.

Description.—Shell fusiform, showing five angulated whorls (the apical whorls and portion of the body whorl wanting); with about twelve

longitudinal costae, which do not extend above the shoulder; ribs crossed by numerous more or less alternating ridges, of which two on the body whorl, about half-way between the shoulder and the anterior end, are noticeably larger than the others; finer lines of growth cross the ridges forming a somewhat rugose sculpture; above the shoulder smooth with a few small revolving raised lines and still smaller arcuated lines of growth.

The figured specimen is the only one known. It resembles very closely *Melongena subcarinata* of the Paris Basin Eocene. There is also a resemblance to *Papillina staminea var.* Harris[1] from Claiborne, Alabama.

Length, 34 mm.; width, 18 mm.

Occurrence.—Aquia Formation. Potomac Creek.

Collection.—Philadelphia Academy of Natural Sciences (No. 6880 of the Lea Memorial Collection).

Genus TUDICLA Bolten.

Tudicla marylandica n. sp.

Plate XXIII, Figs. 1, 1a, 1b.

Description.—Spire flat, concealed except on top by the body whorl which is large, much expanded above, but rapidly contracting below; surface marked by lines of growth, and fine, revolving wrinkles which become strong toward the beak; periphery of body whorl with spines of moderate size; beaks long, narrow, reflexed; columella twisted obtusely.

This species differs from *P. pyrula* Ald. in not having the elevated spire shown in Harris' figure of a Midwayan specimen,[2] and also in not having as elevated a spire, as ovate a mouth, nor being as strongly spinose as the Chickasawan specimens.

Length, 70 mm.; width, 50 x 35 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

[1] Proc. Acad. Nat. Sci. Phila., vol. xlviii, 1896, p. 474, pl. xx, fig. 2.

[2] Bull. Amer. Pal., vol. iv, pl. xix, fig. 2.

TUDICLA sp.

Plate XXIII, Figs. 2, 2a.

Pyropsis (?) sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Pyropsis sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 67, pl. xi, figs. 2*a*, 2*b*.
(?) *Pyropsis pyrula* Harris, 1899, Bull. Amer. Pal., No. 11, p. 46 (In part).

Description.—Several casts of a large *Tudicla* have been found at various localities in the Aquia formation. They differ from *T. marylandica* in having a bluntly angulated shoulder. We have not seen the casts from Fort Washington which Professor Harris referred to *Pyropsis pyrula* but they belong probably to this form.

Length (of fragment), 40 mm.; width, 55 mm.

Occurrence.—AQUIA FORMATION. Clifton Beach, Aquia Creek, Crownsville, Fort Washington (Harris).

Collections.—Maryland Geological Survey, Cornell University.

TUDICLA (?) sp.

Plate XXIII, Fig. 4; Plate XXIV, Fig. 6.

Description.—The cast of a small unknown gastropod is very abundant in the indurated ledge at Aquia Creek. It has an obtuse, conic spire, varying in height, and a body whorl much expanded at the top, but diminishing in width below. The beak is moderately long, straight and slender. The spire is wound on or slightly below the shoulder of the whorl. The periphery of the whorl is tuberculate.

An imperfect shell having all these characters was also found at Popes Creek. It has a thick shell and is ornamented with distant, raised, revolving lines.

Length, 40 (?) mm.; width, 27 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek. AQUIA FORMATION. Aquia Creek, Clifton Beach.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Genus LEVIFUSUS Conrad.

LEVIFUSUS TRABEATUS (?) Conrad.

Fusus trabeatus Conrad, 1833, Fossil Shells of the Tertiary, No. 3 [1st Edit.], p. 29.
Fusus trabeatus Conrad, 1835, Fossil Shells of the Tertiary, No. 3 [2nd Edit.], p. 53, pl. xviii, fig. 1.

Fusus (*Levifusus*) *trabeatus* Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4. (In part.)

Fusus (*Levifusus*) *trabeatus* Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 67. (In part.)

Description.—" Shell subfusiform, ventricose, with revolving elevated striae at the base, and more obscure ones on the spire: body whorl with two distinct rows of tubercles, humeral one continued on the spire." Conrad, 1829.

Several fragments of molds of the exterior, as well as less clearly defined casts of the interior, have been found. They cannot be identified with *L. trabeatus* with certainty. The casts from Aquia Creek which were formerly identified with this species are evidently of an indeterminate *Tudicla*.

Occurrence.—Nanjemoy Formation. Popes Creek.

Collection.—Maryland Geological Survey.

Levifusus trabeatus (?) var.

Plate XXIII, Fig. 3.

Description.—A single, imperfect specimen was found at Woodstock which cannot be distinguished in its present condition from a *Fulgur*. It would be unwise, however, to assume the presence of that genus in the Eocene without better evidence than a single cast. The specimen is too imperfect for description but a figure is given and the form tentatively referred to a variety of the preceding species. The substance of the shell is very thin and apparently smooth. The shoulder is carinate or tuberculate. The suture does not seem to be channeled.

Length, 73 mm.; width, 25-40 mm. (flattened).

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Maryland Geological Survey.

Genus METULA Adams.

Metula marylandica n. sp.

Plate XXIII, Fig. 5.

Description.—Shell small, elongate, six-whorled; sculpture of longitudinal folds and elevated revolving ribs; body whorl with thirteen longi-

tudinal folds, and about fifteen, raised, obtusely rounded, revolving ribs becoming alternate toward the base; other whorls with six ribs; lines of growth fine and sharp; outer lip with ten, irregularly spaced teeth; canal short, slightly curved.

Length, 11 mm.; width, 5 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek, Potomac Creek, 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Genus CHRYSODOMUS Swainson.

Chrysodomus engonatus (Heilprin).

Plate XXIII, Fig. 6.

Fusus (Hemifusus?) engonatus Heilprin, 1880, Proc. Acad. Nat. Sci. Phila., vol. xxxv, p. 372, pl. xx, fig. 8.

Description.—" Shell turreted, of about ten volutions, the first three whorls smooth and convex, the remainder strongly carinated, and transversed by numerous fine revolving lines, which on the median portion of the body whorl alternate with intermediate finer striae; body whorl impressed immediately below the carination (shoulder angulation); lines of growth sinous, and approximating the characteristic lines of the Pleurotomidae; aperture considerably exceeding the spire in length; columella slightly arcuate, and presenting a rudimentary fold at about its central portion." Heilprin, 1880.

Length, 33 mm.; width, 16 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek, Potomac Creek.

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences.

Genus PSEUDOLIVA Swainson.

Pseudoliva sp.

Plate XXIII, Fig. 7.

Description.—Only internal casts of this form have been found. They are not unlike in size and shape to *P. venusta* (Conrad), but it is not safe to attempt a specific determination.

Length, 30 mm.; width, 17 mm.

Occurrence.—Aquia Formation. Upper Marlboro, Hardesty.

Collection.—Maryland Geological Survey.

Superfamily TAENIOGLOSSA.

Family TRITONIDAE.

Genus TRITONIUM Link.

Tritonium showalteri (Conrad).

Plate XXIV, Figs. 1, 1a.

Simpulum showalteri Conrad, 1860, Jour. Acad. Nat. Sci. Phila., vol. iv, p. 292, pl. xlvii, fig. 11.

Description.—" Fusiform; whirls eight, angular, periphery of angle acute, situated below the middle of the whirl; whirls of spire costate longitudinally, but not very distinctly; revolving lines closely arranged, fine, with a few distant prominent lines; three first whirls of the spire smooth, the next two tuberculated; angle tuberculated; a prominent, acute line on the body whirl runs from the upper extremity of the aperture, and a similar finer line between it and the angle above; columella rugose, with a prominent fold near its upper end; labium dentate within." Conrad, 1860.

Length, 26 mm.; width, 13 mm.

Occurrence.—Aquia Formation. Mouth of Paspotansa Creek, 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Family DOLIIDAE.

Genus PYRULA Lamarck.

Pyrula penita var. Conrad.

Plate XXIV, Fig. 2.

Pyrula penita Conrad, 1833, Fossil Shells of the Tertiary, No. 3 [1st Edit.], p. 32.

Pyrula cancellata Lea, 1833, Contrib. to Geol., p. 154, pl. v, fig. 160.

Pyrula elegantissima Lea, 1833, Contrib. to Geol., p. 155, pl. v, fig. 161.

Pyrula tricarinata Conrad, 1835, Fossil Shells of the Tertiary, No. 3 [2nd Edit.], p. 38, pl. xv, fig. 6.

Description.—" Shell subfusiform, reticulated, with three carinations on the body whorl: striæ alternating in size: five volutions; spire elevated and pointed. Lip thickened toward the margin.

"Variety, C. Destitute of carinations, and probably the young shell. Length about an inch." Conrad, 1833.

Several specimens have been found which are very close to this species. They are nearer the *Variety C.* suggested by Conrad and named *P. elegantissima* by Lea.

Length, 27 mm.; width, 12 mm.

Occurrence.—Nanjemoy Formation. Popes Creek.

Collection.—Maryland Geological Survey.

Pyrula (?) sp.

Plate XXIV, Fig. 5.

Description.—Shell thin; body whorl large, convex; sculpture of numerous, closely set, revolving, impressed lines, very strongly and constantly punctate.

Only one specimen has been found and it is very imperfect. The spire is entirely gone.

Length (of fragment), 14 mm.; width, 11 mm.

Occurrence.—Nanjemoy Formation. Popes Creek.

Collection.—Johns Hopkins University.

Genus FULGUROFICUS Sacco.

Fulguroficus argutus Clark.

Plate XXIV, Figs. 3, 3a.

Fulgur argutus Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.

Fulguroficus argutus Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 68, pl. xii, figs. 1*a*, 1*b*.

Fulguroficus triserialis Harris, 1899, Bull. Amer. Pal., No. 11, p. 67, pl. viii, fig. 17. (In part.)

Description.—" Shell moderately short, with four or five whorls; first two whorls apparently smooth; third whorl with faintly impressed spiral lines and minute transverse riblets; later whorls with spinous tubercles at the shoulder; body whorl also with two lower rows of tubercles arranged along strongly elevated spiral ridges and transversely placed vertically above one another; ten to fourteen tubercles in each row; numerous fine spiral threads also pass over the spinous ridges and inter-

spaces; lines of growth somewhat irregular; canal rather long, narrow." Clark, 1896.

This species differs from *F. triserialis* Whitfield in having the three rows of tubercles of nearly equal strength, and spaced at nearly equal distances, in having more elevated spire, and in having that portion of the body whorl, of which the middle row of tubercles is in the center, uniformly convex throughout, instead of sharply angulated at the shoulder and nearly flat below.

Length, 27 mm.; width, 18 mm.

Occurrence.—NANJEMOY FORMATION. Woodstock. AQUIA FORMATION. Potomac Creek, 2 miles below Potomac Creek, Pomonkey Neck, Upper Marlboro.

Collections.—Maryland Geological Survey, U. S. National Museum, Philadelphia Academy of Natural Sciences, Johns Hopkins University.

Genus FUSOFICULA Sacco.

FUSOFICULA JUVENIS (Whitfield).

Plate XXIV, Figs. 4, 4a.

Pyrula juvenis Whitfield, 1865, Amer. Jour. Conch., vol. i, p. 259.
Fusoficula juvenis Harris, 1899, Bull. Amer. Pal., No. 11, p. 66, pl. viii, figs. 15, 16.

Description.—"Shell small and fragile; spire elevated; columella slender, slightly bent; aperture large, elongate, ovate or sub-elliptical; volutions three; marked on the periphery by three distinct carinae or sub-angular revolving ridges, the upper one marked with closely arranged, longitudinally elongated nodes, the others simple; entire surface marked by very fine revolving lines, which are somewhat fasciculate below the lower carina, there being three finer ones between each large one." Whitfield, 1865.

A single specimen of typical form and excellent state of preservation was found.

Length, 23 mm.; width, 11 mm.

Occurrence.—AQUIA FORMATION. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Family CASSIDIDAE.

Genus MORIO Montfort.

Morio brevidentata (Aldrich).

Plate XXIV, Fig. 7.

Cassidaria brevidentata Aldrich, 1885, Jour. Cin. Soc. Nat. Hist., p. 152, pl. iii, fig. 20.

Description.—" Shell, oblong-oval, whorls seven; suture, channeled; surface covered with fine revolving striae; coarser, distant lines upon the body whorl, giving the shell the carinated aspect of the genus; lines of growth fine, a few coarser ones showing on the line of the tubercles; apex, smooth; whorls of the spire carinate and slightly tubercled; a row of upright longitudinal nodes on the shoulder of the body whorl, none below; a single, strong varix on the body whorl; aperture, ovate; inner lip spreading over the whorl, with three plications on the upper part, smooth in the central part and plicate below; outer lip reflected, plicate on the inner edge above and below, smooth in the center; canal, narrow, strongly twisted." Aldrich, 1885.

Length, 30 mm.; width, 20 mm.

Occurrence.—Aquia Formation. 1 mile southeast of Mason Springs, 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Family CYPRAEIDAE.

Genus CYPRAEA Linné.

Cypraea smithii Aldrich.

Plate XXIV, Fig. 8.

Cypraea smithii Aldrich, 1886, Geol. Survey, Ala., Bull. 1, p. 33, pl. v, fig. 3.

Description.—" Shell oblong-ovate, rather flat, surface smooth; labium crenulate within, smooth on the base and flattened, reflected somewhat and raised above base of shell; aperture slightly crenulate within, expanded below." Aldrich, 1886.

Fragments of a *Cypraea* which in their somewhat imperfect condition show no characters which would prevent their being referred to *C. smithii* are fairly abundant in the Potapaco member, but seem to be much restricted in vertical range.

Length, 18 mm.; width, 15 by 8 mm. (crushed).

Occurrence.—Nanjemoy Formation. West of Port Tobacco, ½ mile below Chapel Point, Head of Nanjemoy Creek.

Collection.—Maryland Geological Survey.

Family STROMBIDAE.

Genus CALYPTRAPHORUS Conrad.

Calyptraphorus jacksoni Clark.

Plate XXV, Figs. 1, 1a, 2.

Calyptrophorus jacksoni Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Calyptrophorus jacksoni Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 68, pl. xii, figs. 2*a*, 2*b*.

Description.—" Shell large, solid, many whorled; spire prolonged, acuminate; surface of adult covered with thick, calcareous deposit, entirely enveloping the whorls; inner lip thickened with extensive callosity." Clark, 1896.

This very remarkable form is quite distinct from any other species, but some of the Gulf types approach it in size and amount of callosity. Some of the largest specimens of *C. trinodiferus* Conrad show certain points of similarity, but the Maryland species cannot be confounded with it. In the absence of young shells, the character of the surface decoration is unknown. A large number of specimens have been found in the South River area.

Length (restored), 102 mm.; width, 44 mm.

Occurrence.—Aquia Formation. South River, Upper Marlboro.

Collections.—Maryland Geological Survey, Johns Hopkins University, Museum of Comparative Zoology.

Calyptraphorus trinodiferus Conrad.

Plate XXV, Fig. 3.

Calyptraphorus trinodiferus Conrad, 1857, Proc. Acad. Nat. Sci. Phila., vol. ix, p. 166.
Calyptraphorus trinodiferus Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. iv, pl. xlvii, fig. 29.

Description.—" Subfusiform, with three distinct nodes on the upper part of the body volution; spire subtriangular, having curved longitu-

dinal ribs visible beneath the tunic; rostrum of the spire elongated and curved; labrum with a prominent angle above." Conrad, 1857.

Length, 45 mm.; width, 18 mm.

Occurrence.—Nanjemoy Formation. Potomac Creek (Zone 11). Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Calyptraphorus trinodiferus (?) var.

Plate XXV, Figs. 4, 4a.

Description.—This form has the prolonged spire and longitudinal ribbing of *C. trinodiferus,* differing from it only in lacking the nodes. It might perhaps be referred to a variety of *C. velatus,* but the characters which separate it from *C. velatus* seem less likely to be accidental than those separating it from *C. trinodiferus.* In the Philadelphia Academy of Natural Sciences are a few specimens of *C. velatus* which have the prolonged spire of this form, but none have the ribbing on the spire.

Length, 46 mm.; width, 15 mm.

Occurrence.—Nanjemoy Formation. Popes Creek. Aquia Formation. 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Family APORRHAIDAE.

Genus APORRHAIS da Costa.

Aporrhais potomacensis n. sp.

Plate XXV, Figs. 5, 6.

Description.—Shell fusiform; spire elevated, pointed; body whorl large; outer lip much expanded; digitations, two, slender and long; posterior digitation about twice as long as the anterior; callus on the inner lip thick; whorls strongly convex and somewhat angulated below the middle; body whorl with two obtuse revolving ribs, which extend down the middle of the digitations, and disappear in the opposite direction beneath the callus on the labium; about twenty longitudinal ribs on each whorl, with a deep curve below the suture, overridden by fine, raised, close-set, revolving lines.

Length, 25 mm.; width (of body whorl), 10 mm.; length of posterior digitation, 22 mm.

Occurrence.—Aquia Formation. 1 mile northeast of Piscataway, Paspotansa Creek, 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Family TURRITELLIDAE.

Genus TURRITELLA Lamarck.

Turritella mortoni Conrad.

Plate XXVI, Figs. 1-5.

Turritella mortoni Conrad, 1830, Jour. Acad. Nat. Sci. Phila., vol. vi, p. 221, pl. x, fig. 2.

Turritella mortoni Conrad, 1832, Fossil Shells of the Tertiary, No. 3 [2nd Edit.], p. 40, pl. xv, fig. 11.

Turritella mortoni Morton, 1834, Synopsis Organ. Rem. Cretaceous Group, App., p. 4.

Turritella mortoni H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 107.

Turritella mortoni Conrad, 1865, Amer. Jour. Conch., vol. i, p. 32.

Turritella mortoni de Gregorio, 1890, Ann. Geol. et Pal., p. 122, pl. xi, fig. 7.

Turritella mortoni var. postmortoni Harris, 1894, Amer. Jour. Sci., ser. iii, vol. xlvii, p. 303, figs. 1, 2, 3.

Turritella mortoni Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.

Turritella mortoni Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 69, pl. xiii, figs. 1*a*–1*e*.

Turritella mortoni Harris, 1899, Bull. Amer. Pal., No. 11, p. 74, pl. x, figs. 3, 4.

Description.—"Shell turreted, conical, thick, with revolving distant, and finer intervening striae; whorls with an elevated acute carina near the base of each; volutions about eleven; the striae are largest on the elevations of the whorls, which are slightly concave above, and abruptly terminate at the sutures; the lines of growth on the last whorl are strong and much undulated." Conrad, 1830.

This important species was one of the first to be recognized in the Maryland Eocene, and has been generally regarded as one of the most characteristic, as it is one of the most common forms. At times it makes up whole beds, as shown in the Paspotansa member of the Aquia formation at Aquia Creek, Potomac Creek, and other neighboring localities.

Turritella mortoni shows very great variations in the form and deco

ration of the whorls, and if it were not for the great number of intermediate types one might readily establish several independent species.

Some specimens have nearly equally rounded whorls with evenly spaced spiral lines, while others are prominently carinated toward the base of the whorl and the spiral threads are irregularly spaced, varying in prominence and number.

A variety named *postmortoni* by Harris is characterized by its rather smaller size, plainer surface, and extremely sharp basal carina. Figure 5 represents this form.

Length, 130 mm.; width, 33 mm.

Occurrence.—Aquia Formation. Fort Washington, 1 mile northeast of Piscataway, Northwest of Piscataway (W. of Tinkers Cr.), Brooks Estate near Seat Pleasant, Glymont, Liverpool Point, Clifton Beach, 1 mile southeast of Mason Springs, Aquia Creek, Potomac Creek, Upper Marlboro, Sheckels Farm near South River, 1 mile west of Hardesty, Rolph's Landing.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Turritella humerosa Conrad.

Plate XXVII, Figs. 1, 1a.

Turritella humerosa Conrad, 1835, Trans. Geol. Soc., Penn., p. 340, pl. xiii, fig. 3.
Turritella humerosa H. C. Lea, 1848, Proc. Acad. Nat. Sci., Phila., vol. iv, p. 107.
Turritella humerosa Conrad, 1865, Amer. Jour. Conch., vol. i, p. 32.
Turritella humerosa Conrad, 1866, Smith. Misc. Coll. (200), p. 11.
Turritella humerosa Harris, 1894, Amer. Jour. Sci., ser. iii, vol. xlvii, p. 303.
Turritella humerosa Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Turritella humerosa Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 70, pl. xiv, fig. 1.
Turritella humerosa Harris, 1899, Bull. Amer. Pal., No. 11, p. 75, figs. 5, 6, 7.

Description.—"Shell turreted, subulate; whorls with fine regular revolving striae; an obtuse slight elevation on the summit, a shallow groove at the base of each." Conrad, 1835.

Turritella humerosa, although not an uncommon species, is far less frequent than *T. mortoni.* It is very readily separated from the latter by its flat whorls and prominent subsutural carina, which makes the whorls of nearly equal diameter above and below.

This species apparently never reaches the dimensions of *T. mortoni*, but is commonly associated with it. Like *T. mortoni*, it is largely confined to the Paspotansa member of the Aquia Formation.

Length, 140 mm.; width, 25 mm.

Occurrence.—Aquia Formation. Fort Washington, Clifton Beach, Aquia Creek, 1 mile southeast of Mason Springs, Glymont, Mouth of Paspotansa Creek, 1 mile northeast of Piscataway, Near Annapolis, Between Buena Vista and Collington, Tinkers Creek, Liverpool Point, Upper Marlboro, Sheckels Farm near South River, Brooks Estate near Seat Pleasant.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Turritella potomacensis n. sp.

Plate XXVII, Figs. 2, 3.

Description.—Shell slender, elongate; whorls many; each whorl carinated at the base, diminishing sharply in diameter toward the apex, and concave in the middle; sculpture consisting of one or two strong, elevated carinae at the base of the whorl, and about five moderately strong ones, irregularly spaced above them, and between these secondary alternating threads and fine, raised, revolving lines; some of the carinae, especially those toward the middle of the whorl, are beaded.

Length, 45 mm.; width, 10 mm.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock.

Collection.—Maryland Geological Survey.

Genus MESALIA Gray.

Mesalia obruta (Conrad).

Plate XXVII, Fig. 4.

Turritella obruta Conrad, 1833, Fossil Shells of the Tertiary, No. 4, p. 45; No. 3 [2nd Edit.], 1835, p. 40. pl. xv, fig. 12.

Turritella venusta Conrad, 1835, Trans. Geol. Soc., Penn., vol. i, p. 336.

Description.—" Subulate, with about eleven slightly convex volutions, with about seven sharp elevated striae on each, and intermediate fine crowded lines; space about the suture indented." Conrad, 1833.

This form is very abundant in the Nanjemoy formation, and occurs near the top of the Aquia formation at Upper Marlboro, in the indurated ledge and just above it, and also in the same bed near South River bridge.

Length, 30 mm.; width, 10 mm.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock. Aquia Formation. Upper Marlboro, Sheckels Farm near South River.

Collection.—Maryland Geological Survey.

Family VERMETIDAE.

Genus VERMETUS Adams.

Vermetus sp.

Plate XXVII, Figs. 5, 5a, 6, 7.

Vermetus sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Vermetus sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 71, pl. xiv, figs. 2*a*, 2*b*.

Description.—Fragmentary masses of this form are found at various points in the Potomac River region, but no specimen sufficiently well preserved for specific determination has been obtained. The fragments, however, probably represent a new species. The form is characterized by longitudinal furrows, giving it a somewhat angulated appearance, and by transverse, scaly lines interrupted by the furrows. The average diameter of the tubes is about 2 mm.

Occurrence.—Aquia Formation. Piscataway Creek, Potomac Creek, Rolph's Landing, Upper Marlboro.

Collections.—U. S. National Museum, Johns Hopkins University, Maryland Geological Survey.

Family NATICIDAE.

Genus NATICA Lamarck.

Natica cliftonensis Clark.

Plate XXVIII, Fig. 1.

Natica cliftonensis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Natica cliftonensis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 69, pl. xii, fig. 4.

Description.—"Shell small, with four or five whorls; spire low; body whorl much inflated; suture well marked; surface smooth, except for lines of growth; aperture large, with thick callus." Clark, 1896.

In addition to the type we have only a crushed *Natica* from Woodstock that may represent this species.

Length, 10 mm.; width 12 mm.

Occurrence.—Nanjemoy Formation. Woodstock. (?) Aquia Formation. Clifton Beach.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Genus LUNATIA Gray.

Lunatia marylandica Conrad.

Plate XXVIII, Figs. 2, 2a, 3.

Lunatia marylandica Conrad, 1865, Amer. Jour. Conch., vol. i, pp. 26, 211, pl. xxi, fig. 11.

Lunatia marylandica Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.

Lunatia marylandica Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 69, pl. xii, figs 3*a*–3*c*.

cf. Natica eminula var. Harris, 1899, Bull. Amer. Pal., No. 11, p. 88, pl. xi, fig. 22.

Description.—" Suborbicular or subovate, volutions 5; spire short, whorls convex, subcontracted below the suture; labium with a callus on the upper part, reflected over the umbilical margin; umbilicus moderate in outline, profound, showing most of the volutions." Conrad, 1865.

The stratigraphic and geographic range of this species is very great. It is larger, however, and more abundant in the lower beds of the Aquia formation. The affinities of the species are with *L. eminula* (Conrad) of Alabama, especially with *L. eminula var.* Harris, of the Alabama Chickasawan, which is an intermediate member of a series of which the Claibornian *L. eminula* and *L. marylandica* are end members.

The separation of these species is very difficult, and possibly all the forms ought to be referred to *L. eminula* which is the older name. The Maryland forms show almost, if not quite, the complete range of variation of the series.

Length, 32 mm.; width, 30 mm.

Occurrence.—Nanjemoy Formation. East and west of Port Tobacco, Woodstock. Aquia Formation. 1 mile northeast of Piscataway, Potomac Creek, 2 miles below Potomac Creek, Upper Marlboro, Liverpool Point, Mouth of Paspotansa Creek, Aquia Creek, 1 mile southeast of Mason Springs, Glymont, Hardesty, Fort Washington.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Family CAPULIDAE.

Genus CALYPTRAEA Lamarck.

Calyptraea aperta (Solander).

Plate XXVIII, Figs. 4, 5.

Trochus apertus Solander, 1766, Foss. Haut., p. 9, figs. 1, 2.
Calyptraea trochiformis Lamarck, 1804, Ann. Mus. d'Hist. Nat., vol. i, p. 15, fig. 3.
Calyptraea trochiformis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Calyptraea trochiformis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 70.
Calyptraea aperta Harris, 1899, Bull. Amer. Pal., No. 11, p. 84, pl. xi, figs. 13–16.

Description.—Shell orbicular, thin, obtusely conical; volutions three or four; apex subcentral; later whorls spinose; whole surface (except protoconch) roughened with irregular, wavy lines of growth, or a vermicular shagreening; septum slightly concave; pillar reflected, giving the appearance of an umbilicus.

This species is represented, usually in a poorly preserved state, in nearly all the beds and localities of the Maryland Eocene. The largest specimens are in the Aquia formation.

Length, 15 mm.; width, 28 mm.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock, East and west of Port Tobacco, ½ mile below Chapel Point. Aquia Formation. Fort Washington, Glymont, Clifton Beach, Liverpool Point, Upper Marlboro, Aquia Creek, Potomac Creek, 2 miles below Potomac Creek, 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Family LITTORINIDAE.

Genus LITIOPA Rang.

Litiopa marylandica n. sp.

Plate XXVIII, Figs. 6, 6a.

Description.—Shell thin, with six whorls; the first two whorls smooth, the third with fine, closely-set, revolving striations from suture to su-

ture, the fourth with striations on the upper half, the lower half being smooth, the fifth and sixth (body) whorls smooth, except for very faint, revolving lines, which are less distinct than the lines of growth, and about eight, sharp, revolving lines around the umbilicus; callosity on the labium thin; umbilicus moderate; mouth large; columella concave above.

Length, 8 mm.; width, 4 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Superfamily PTENOGLOSSA.

Family SOLARIIDAE.

Genus SOLARIUM Lamarck.

Solarium sp.

Plate XXVIII, Figs. 7, 7a.

Solarium sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Solarium sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 71, pl. xiv, figs. 4*a*, 4*b*.

No new material belonging to this genus has been obtained except an indeterminate fragment from near Mason Springs. Neither this, nor the cast from Aquia Creek, give any clew to the specific characters.

Length, 6 mm.; width, 16 mm.

Occurrence.—Aquia Formation. Aquia Creek, 1 mile southeast of Mason Springs.

Collection.—Johns Hopkins University, Maryland Geological Survey.

Family SCALARIIDAE.

Genus SCALA Klein.

Scala virginiana Clark.

Plate XXVIII, Figs. 8, 8a, 9, 9a.

Scala virginiana Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Scala virginiana Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 71, pl. xiv, figs. 3*a*, 3*b*.

Description.—" Shell probably seven- or eight-whorled; surface covered with a uniform, fine, spiral striation; varices fifteen to the whorl,

inflected forward and prominent; some of the varices are more prominent than others, and in a few instances are partially divided by a central groove; aperture nearly round." Clark, 1896.

Some specimens show a large umbilicus, in others it is absent.

Length, 22 mm.; width, 14 mm.

Occurrence.—Aquia Formation. Aquia Creek, Potomac Creek.

Collection.—U. S. National Museum, Philadelphia Academy of Natural Sciences.

Scala potomacensis n. sp.

Plate XXVIII, Fig. 10.

Description.—Shell elongate, moderately slender, eight-whorled; mouth round; base with numerous, closely-set, revolving lines and folds radiating to the varices; whorls closely-set; moderately and uniformly convex; varices low, obtuse, twenty-five on the body whorl, and about as many on the whorls of the spire, stronger than ordinary, and occurring at irregular intervals; raised revolving threads, about 30 in number, alternating and doubly alternating in strength, run between without crossing the varices.

Length, 20 mm.; width, 8 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Scala sessilis Conrad.

Plate XXVIII, Fig. 11.

Scala sessilis Conrad, 1833, Fossil Shells of the Tertiary, No. 4, p. 45.

Description.—" Subulate, with rather thick longitudinal costae, and minute crowded spiral lines; whorls nine, sessile or contiguous; base of the body whorl carinated." Conrad, 1833.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Scala carinata Lea.

Plate XXVIII, Fig. 12.

Scala carinata Lea, 1833, Contrib. to Geol., p. 116, pl. iv, fig, 103.

Description.—" Shell conical, closely ribbed, carinate on the inferior part of the last whorl; substance of the shell thick; spire elevated,

pointed; ribs about twelve, lamelliform; whorls six, rounded; mouth round." Lea, 1833.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek, Upper Marlboro.

Collection.—Maryland Geological Survey.

Superfamily GYMNOGLOSSA.

Family PYRAMIDELLIDAE.

Genus TURBONILLA Risso.

Subgenus PYRGISCUS Philippi.

Turbonilla potomacensis n. sp.

Plate XXIX, Fig. 1.

Description.—Shell stout; whorls eight, moderately convex; about twenty-five slightly curved, longitudinal ribs on the body whorl, crossed by eight, impressed, revolving lines, which are deepest between the ribs; base of shell with impressed, revolving lines, and faint, radiating ribs; mouth ovate.

Length, 10 mm.; width, 4 mm.

Occurrence.—Aquia Formation. Potomac Creek, 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Genus TUBA Lea.

Tuba marylandica n. sp.

Plate XXIX, Fig. 2.

Description.—Shell elongate; whorls seven, strongly convex, covered with eight raised revolving threads, with narrower interspaces; threads strongly beaded by intersections with raised longitudinal lines.

Length, 12 mm.; width, 5 mm.

Occurrence.—Nanjemoy Formation. Popes Creek. Aquia Formation. Mouth of Paspotansa Creek, 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Genus ODOSTOMIA Fleming.

Odostomia trapaquara (Harris).

Plate XXIX, Fig. 3.

Syrnola trapaquara Harris, 1895, Proc. Acad. Nat. Sci. Phila., vol. xlvii, p. 77, pl. viii, fig. 10.

Description.—" Size and general form as indicated by the figure; whorls 7; 1 small, sinistral; 2-7 polished, slightly tumid, with a well-marked suture; aperture moderate, striate within; one strong plait on the columella." Harris, 1895.

This species has some resemblance to the figure of *Acteon melanellus* Lea, but it tapers more gradually, has shorter whorls, stronger lines of growth and no revolving lines (or almost none), while they are strong in *A. melanellus.*

Our specimens are very different from the Chickasawan form—*O. insignifica* Aldrich, which Harris regards as a synonym of *O. trapaquara.*

Length, 7 mm.; width, 2.5 mm.

Occurrence.—Aquia Formation. Potomac Creek, 2 miles below Potomac Creek, Upper Marlboro.

Collection.—Maryland Geological Survey.

Family EULIMIDAE.

Genus NISO Risso.

Niso umbilicata (Lea).

Plate XXIX, Fig. 4.

Pasithea umbilicata Lea, 1833, Contrib. to Geol., p. 103, pl. iv, fig. 85.

Description.—" Shell elevated above, rounded below, subcarinate, polished; substance of the shell thin; apex acute; suture linear; umbilicus large; whorls nine, flattened; mouth subovate, acutely angular above, one-fifth the length of the shell; columella incurved at base; margin entire. . . . Its umbilicus is wide, with a large spiral groove. On some of the whorls the line of growth may be indistinctly seen." Lea, 1833.

Length, 24 mm.; width, 5 mm.

Occurrence.—Aquia Formation. Potomac Creek.

Collection.—Maryland Geological Survey.

Order ASPIDOBRANCHIATA.

Suborder RHIPIDOGLOSSA.

Family TROCHIDAE.

Genus GIBBULA Risso.

GIBBULA GLANDULA (Conrad).

Plate XXIX, Fig. 5.

Monodonta glandula Conrad, 1830, Jour. Acad. Nat. Sci. Phila., vol. vi, pp. 214, 220, pl. ix, fig. 15.

Monodonta glandula H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 102.

Monodonta glandula Conrad, 1866, Smith. Misc. Coll. (200), p. 11.

Gibbula glandula Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Gibbula glandula Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 72, pl. xiv, fig. 5.

Description.—" Shell conical, with about four convex volutions; revolving striae fine, crowded and wrinkled; suture deeply impressed; right lip toothed within at the base; margin entire.

" The teeth or tubercles extend to the base of the columella of this shell." Conrad, 1830.

Length, 8 mm.; width, 7 mm.

Occurrence.—AQUIA FORMATION. Piscataway (Conrad), Potomac Creek, Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey, Philadelphia Academy of Natural Sciences.

Genus CALLIOSTOMA Swainson.

CALLIOSTOMA sp.

Description.—Two specimens of *Calliostoma,* both too imperfect either to figure or to describe, were found in the Aquia formation. The one from below Potomac Creek is part of the base of the body whorl. It shows a strong basal carina, and revolving threads of various size, all slightly granulate. The fragment from Upper Marlboro does not show the surface decoration, but has a deep groove in the middle of the whorl.

Occurrence.—AQUIA FORMATION. Upper Marlboro, 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Family FISSURELLIDAE.

Genus FISSURIDEA Swainson.

FISSURIDEA MARLBOROENSIS n. sp.

Plate XXIX, Figs. 6, 6a.

Description.—Shell ovate, depressed; apex anteriorly situated, acute; foramen keyhole-shaped, anterior to the apex, plane sloping forward; internal callus shaped like the end of a gun-stock, deeply dinted behind; surface sculptured by fine, impressed, radiating lines, with broad and flat interspaces toward the periphery, raised and rounded toward the apex; interspaces doubly alternating in width or height, every fourth being much wider, while of each group of intervening narrower ones that in the middle is slightly wider than the rest; alternation becomes simple on the posterior slope, with double alternation strongest on the anterior slope.

Length, 17.5 mm.; width, 12 mm.; height, 6 mm.

Occurrence.—AQUIA FORMATION. Upper Marlboro.

Collection.—Maryland Geological Survey.

Class SCAPHOPODA.

Order SOLENOCONCHIA.

Family DENTALIIDAE.

Genus DENTALIUM Linné.

DENTALIUM MINUTISTRIATUM Gabb.

Plate XXIX, Fig. 7.

Dentalium minutistriatum Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd Ser., vol. iv, p. 386, pl. lxvii, fig. 46.

Description.—"Very slightly curved, marked by numerous small longitudinal ribs, all of the same size, no trace of alternation; aperture round." Gabb, 1860.

This form differs from *D. mississippiensis* in having finer, non-alternate ribbing, and not attaining to so great a size.

The figured specimen (besides which only fragments have been found) is strongly and regularly compressed in the plane at right angles to that of curvature. So natural does the compression appear that the individual was referred to the genus *Compressidens* of Pilsbry. But other fragments have been found which have a perfectly round aperture, and faint cracks have been discovered along the lines of greatest curvature of the compressed specimen, and therefore the character must probably be regarded as accidental.

Length, 17 mm.; width, 1.75 x 2.5 mm. (flattened).

Occurrence.—NANJEMOY FORMATION. Popes Creek.

Collection.—Maryland Geological Survey.

DENTALIUM MISSISSIPPIENSIS Conrad.

Plate XXIX, Fig. 8.

Dentalium mississippiensis Conrad, 1848, Jour. Acad. Nat. Sci. Phila., 2nd Ser., vol. i, p. 112, pl. xi, fig. 1.

Description.—" Curved, attenuated above, longitudinally striated, the lines alternating in size. . . . It differs from *D. thalloides* in having more numerous and much less prominent lines." Conrad, 1848.

Length, 36 mm.; width, 6 mm.

Occurrence.—NANJEMOY FORMATION. West of Port Tobacco, 1 mile southeast of Piscataway. AQUIA FORMATION. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family SIPHONODENTALIIDAE.

Genus CADULUS Philippi.

CADULUS ABRUPTUS Meyer and Aldrich.

Plate XXIX, Fig. 9.

Cadulus abruptus Meyer and Aldrich, 1887, Jour. Cin. Soc. Nat. Hist., vol. ix, No. 2, p. 40, pl. ii, fig. 2.

Cadulus bellulus Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Cadulus bellulus Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 72, pl. xiv, fig. 6.

Description.—" Rather large, somewhat depressed. Inflation very near to the larger aperture and suddenly decreasing." Meyer and Aldrich, 1886.

Thin, polished, slightly arched; much contracted near the anterior extremity; anterior opening subcircular, posterior simple.

This species differs from *C. subcoarctatus* Gabb in having the constriction begin much nearer the aperture. There is no longitudinal striation.

Length, 8 mm.; width, 1.25 mm.

Occurrence.—Nanjemoy Formation. Woodstock, Head of Nanjemoy Creek, East and west of Port Tobacco, 1½ and 2½ miles above Popes Creek, 1 mile southeast of Piscataway, Upper Marlboro (deep cut near Chesapeake Beach R. R. station), Well at Chesapeake Beach (90-92 feet). Aquia Formation. Aquia Creek, Liverpool Point, Clifton Beach, 1 mile northeast of Piscataway.

Collection.—Maryland Geological Survey, Johns Hopkins University.

Class PELECYPODA.

Order TELEODESMACEA.

Family TEREDINIDAE.

Genus TEREDO Linné.

Teredo virginiana Clark.

Plate XXX, Figs. 1, 1a, 2, 2a, 3.

Teredo virginiana Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Teredo virginiana Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 72, pl. xv, figs. 5a–5c.
Teredo virginiana Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, part iv, p. 813.

Description.—"Shell unknown; tube thick, cylindrical, irregularly curved, rapidly tapering; surface smooth, or with fine lines of growth; prominent transverse segment near posterior extremity of the tube in some of the forms." Clark, 1896.

This type compared with the forms described from the Alabama Tertiary shows various points of dissimilarity, and even in the absence of the valves seems, from its common occurrence, worthy of a name.

The tubes often occur in large masses in pieces of lignite.

Diameter of tube (maximum), 5 mm.

Occurrence.—Nanjemoy Formation, ½ mile below Chapel Point. Woodstock, Hills Bridge, West of Port Tobacco, Upper Marlboro (deep

cut near Chesapeake Beach R. R. station). Aquia Formation. Upper Marlboro, 2 miles below Potomac Creek, 1 mile southeast of Mason Springs, Clifton Beach, 1 mile northeast of Piscataway.

Collections.—Johns Hopkins University, Maryland Geological Survey, Philadelphia Academy of Natural Sciences.

Family PHOLADIDAE.

Genus PHENACOMYA Dall.

Phenacomya petrosa (Conrad).

Plate XXX, Figs. 4, 4a, 4b.

Pholas petrosa Conrad, 1842, Proc. Nat. Inst., Bull. ii, p. 193, pl. ii, fig. 4.
Pholas petrosa Conrad, 1846, Amer. Jour. Sci., ser. ii, vol. i, p. 213, pl. i, fig. 1.
Pholas petrosa H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 104.
Pholas petrosa Conrad, 1865, Amer. Jour. Conch., vol. i, p. 2.
Pholas petrosa Conrad, 1866, Smith. Misc. Coll. (200), p. 9.
Pholas (?) *petrosa* Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Pholas (?) *petrosa* Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 73, pl. xv, figs. 1*a*–1*c*.
Phenacomya petrosa Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, part iv, p. 823.

Description.—"Ovate-acute; anteriorly profoundly ventricose; radii sharp and numerous; dorsal margin obliquely rectilinear from the summit of the umbo; base obliquely subrectilinear; posterior side produced, cuneiform." Conrad, 1842.

This form is apparently restricted to the limestone ledge, known as Zone 5.

Length, 85 mm.; height, 35 mm.

Occurrence.—Aquia Formation. "Piscataway" (Conrad), Fort Washington, Aquia Creek, Clifton Beach.

Collections.—Johns Hopkins University, Maryland Geological Survey, Philadelphia Academy of Natural Sciences.

Family GASTROCHAENIDAE.

Genus GASTROCHAENA Spengler.

Gastrochaena sp.

Plate XXX, Fig. 5.

Gastrochaena sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Gastrochaena sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 73, pl. xv, fig. 6.

Casts of the tubes of *Gastrochaena* are common in the indurated layer, Zone 5, of the Aquia Creek stage, and also occur at higher horizons.

Few of the specimens obtained show any traces of the shell substance, and rarely impressions of the transverse striations of the tube wall.

Occurrence.—Aquia Formation. Aquia Creek, Upper Marlboro.

Collection.—Johns Hopkins University.

Family SAXICAVIDAE.

Genus PANOPEA Menard.

Panopea elongata Conrad.

Plate XXXI, Figs. 1-5.

Panopaea elongata Conrad, 1835, Trans. Geol. Soc. Penn., vol. i, p. 339, pl. xiii, fig. 1.
Panopaea elongata Conrad, 1846, Amer. Jour. Sci., ser. ii, vol. i, p. 215, pl. i, fig. 2.
Panopaea elongata H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 103.
Glycymeris elongata Conrad, 1854, Proc. Acad. Nat. Sci., Phila., vol. vii, p. 29.
Glyeymeris elongata Conrad, 1865, Amer. Jour. Conch., vol. i, p. 2.
Glycymeris elongata Conrad, 1866, Smith. Misc. Coll. (200), p. 8.
Panopaea elongata Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 4.
Panopaea elongata Clark, Bull. 141, U. S. Geol. Survey, p. 75, pl. xix, figs. 1*a*–1*c*.
Panopea elongata Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 828.

Description.—"Shell oblong, produced, surface with distinct concentric irregular undulations; beaks distant from the anterior margin." Conrad, 1835.

Since at most localities casts alone are found, the following important character has thus been overlooked, viz., that the surface is covered with closely-set, radiating lines of minute granules, which when worn show as lines of punctae, or give the surface an irregularly honeycombed appearance.

Length, 85 mm.; width, 43 mm.

Occurrence.—Aquia Formation. Fort Washington, Winchester, "Piscataway" (Conrad), Tinkers Creek 1 mile north of Piscataway, 1 mile northeast of Piscataway, 1 mile southeast of Mason Springs, Hardesty, R. R. cut near Seat Pleasant, Aquia Creek, Potomac Creek, Paspotansa Creek, 2 miles below Potomac Creek, Marshall Hall, Upper Marlboro, Clifton Beach, Rolphs Landing, Glymont.

Collections.—Johns Hopkins University, Maryland Geological Survey, Philadelphia Academy of Natural Sciences, U. S. National Museum.

Family CORBULIDAE.

Genus CORBULA Lamarck.

CORBULA SUBENGONATA Dall.

Plate XXXII, Figs. 1, 1a, 2, 2a, 2b.

Corbula nasuta Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Corbula nasuta Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 74.
Corbula subengonata Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 841.

Description.—"This form is smaller, less inflated, thinner, and with more nearly parallel dorsal and ventral borders than *C. alabamiensis.* The sculpture is finer than in *C. engonata,* which is a more elongated species." Dall, 1898.

The species was thus defined by Dr. Dall to include the forms from the Chickasawan of Alabama, which had previously been called *C. alabamiensis* Lea or *C. alabamiensis var.* It is probably the ancestral form of the Clairbornian *C. alabamiensis* Lea.

This species is very common in the Maryland and Virginia Eocene. Its slightly elevated umbones and the absence of rostrated posterior surface separate it from the other species of this genus. In its occurrence it differs from our other Eocene species of *Corbula* in that it is most abundant in the lower beds.

Length, 11 mm.; height, 6 mm.

Occurrence.—NANJEMOY FORMATION. Woodstock, Popes Creek. AQUIA FORMATION. Glymont, Clifton Beach, 6 miles east of Washington, Mattawoman Creek, 2 miles below Potomac Creek, 1 mile southeast of Mason Springs, 1 mile northeast of Piscataway.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum.

CORBULA ALDRICHI Meyer.

Plate XXXII, Figs. 3, 3a, 4, 4a, 5, 5a, 6, 6a.

Corbula aldrichi Meyer, 1885, Amer. Jour. Sci., ser. iii, vol. xxx, p. 67.
Corbula aldrichi Aldrich, 1886, Bull. i, Ala. Geol. Survey, p. 83, pl. i, fig. 21.
Corbula aldrichi Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Corbula aldrichi Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 74.

Description.—"It has radiating striae on the umbonial part of the surface, a characteristic which I had not seen before in a Corbula." Meyer, 1885.

"Rounded trigonal; ventricose; posterior side carinated; beak small, curved anteriorly, in the left valve nearly in the middle; right valve briefly rostrated; in both valves the umbonial part is without concentric ribs, but with impressed, radiating lines—the ventral part with concentric ribs." Aldrich, 1886.

This remarkable form, with its radiating lines upon the umbonial portions of the shell, is very common. The Maryland form differs in no essential particulars from the Gulf type.

Length, 11 mm.; height, 7 mm.

Occurrence.—Nanjemoy Formation. Upper Marlboro (deep cut near Chesapeake Beach R. R. station), East and west of Port Tobacco, Head of Nanjemoy Creek, ½ mile below Chapel Point, Popes Creek, 1¾ miles above Popes Creek, 2¼ miles above Popes Creek, Woodstock, 1 mile southeast of Piscataway. Aquia Formation. Aquia Creek, Liverpool Point, Clifton Beach.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum.

Corbula oniscus Conrad.

Plate XXXII, Figs. 7, 7a, 8, 8a, 8b.

Corbula oniscus Conrad, 1833, Amer. Jour. Sci., vol. xxiii, p. 341.
Corbula oniscus Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Corbula oniscus Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 75.
Corbula (*Aloidis*) *oniscus* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 843.

Description.—"Shell elevated; larger valve ventricose, with profound sulci terminating at the umbonial slope, which is carinated; posterior extremity narrowed and truncated, from the posterior angle of which a carina extends to the apex, nearly parallel with that of the umbonial slope; superior valve concentrically striated. Length, one-third of an inch." Conrad, 1833.

This species, characterized by its solid form and numerous concentric, wrinkled, approximate lines and prominently rostrated posterior surface, is common at several localities in the Maryland Eocene. None of the specimens obtained reach the size of the larger individuals in the Gulf Eocene.

Length, 10 mm.; height, 7 mm.

Occurrence.—NANJEMOY FORMATION. East and west of Port Tobacco, Woodstock, Popes Creek, $2\frac{1}{2}$ miles above Popes Creek, Head of Nanjemoy Creek, Upper Marlboro (deep cut near Chesapeake Beach R. R. station), 1 mile southeast of Piscataway. Hills Bridge? · AQUIA FORMATION. Glymont.

Collection.—Maryland Geological Survey.

Family SOLENIDAE.

Genus SOLEN Linné.

SOLEN LISBONENSIS (?) Aldrich.

Plate XXXIII, Fig. 1.

Solen lisbonensis Aldrich, 1886, Bull. i, Ala. Geol. Survey, p. 37, pl. iv, fig. 4.
Solen sp. Harris, 1897, Bull. Amer. Pal. No. 9, p. 66, pl. xiv, fig. 9.
Solen (Plectosolen) lisbonensis Dall, 1900, Trans. Wagner Free Inst. Sci., vol. iii, pt. v, p. 953.
(?) *Solen (Plectosolen) lisbonensis var. abruptus* Dall, 1900, Trans. Wagner Free Inst. Sci., vol. iii, pt. v, p. 953.

Description.—" Shell linear, nearly straight; posterior subtruncate; anterior obliquely rounded with a depressed space behind running to the beaks; lines of growth prominent, bending at right angles along a line running obliquely from the beaks to the junction of the posterior and ventral margins. Anterior widely gaping." Aldrich, 1886.

The references given above are the only records we have of the occurrence of this genus in the Eocene of Eastern North America. The two specimens from the Potomac River are both imperfect and neither shows any characters upon which they can be specifically separated from *S. lisbonensis*. The lines of growth on our specimens do not bend quite as sharply as they do in Aldrich's figure. In this respect they are more like the figure published by Professor Harris. Our specimens are smaller than either of those figured from Alabama. In the publication above noted, Dr. Dall describes a *variety abruptus* under *S. lisbonensis*. This differs from our form even more than the typical *S. lisbonensis* does.

Length (of fragment), 32 mm.; width, 9 mm.

Occurrence.—NANJEMOY FORMATION. ½ mile below Chapel Point, Woodstock.

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences (No. 6224).

Family TELLINIDAE.

Genus TELLINA Deshayes.

Subgenus ANGELUS Megerle.

TELLINA (ANGELUS) VIRGINIANA Clark.

Plate XXXIII, Fig. 3.

Tellina virginiana Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Tellina virginiana Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 76, pl. xv, fig. 4.
Tellina greggi Harris, 1897, Bull. Amer. Pal. No. 9, p. 72. (In part.)
Tellina (Angelus) virginiana Dall, 1900, Trans. Wagner Free Inst. Sci., vol. iii, pt. v, pp. 1015, 1016.

Description.—"Shell elongated, thin, compressed; posteriorly very short, angular, and slightly folded; anteriorly rounded and elongated; umbones posteriorly situated; two small cardinal teeth and indistinct lateral teeth; pallial sinus obscure. Exterior covered with fine concentric lines following lines of growth." Clark, 1896.

This species is more abundant in the Nanjemoy formation, but the specimens from the Aquia formation are much larger.

Professor Harris has suggested the identity of this form with *T. greggi* of Alabama, but further study has shown them to be undoubtedly distinct. Dr. Dall agrees with us in this opinion.

Length, 38 mm. (average, 18 mm.); height, 25 mm. (average, 13 mm.).

Occurrence.—NANJEMOY FORMATION. Woodstock, Popes Creek, East and west of Port Tobacco, Charles Branch between Rosaryville and Upper Marlboro, 2½ and 3 miles above Popes Creek. AQUIA FORMATION. Aquia Creek, Clifton Beach, 2 miles below Potomac Creek, 1 mile southeast of Mason Springs, Fort Washington.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Section PERONIDIA DALL.

TELLINA (PERONIDIA ?) WILLIAMSI Clark.

Plate XXXIII, Figs. 2, 2a.

Tellina williamsi Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Tellina williamsi Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 76, pl. xv, figs. 3*a*, 3*b*.
Tellina subtriangularis Harris, 1897, Bull. Amer. Pal., No. 9, p. 73. (In part).
Tellina (*Peronidia?*) *williamsi* Dall, 1900, Trans. Wagner Free Inst. Sci., vol. iii, pt. v, p. 1016.

Description.—" Shell small, rather solid, not strongly inequilateral; posterior shorter; surface ornamented with elevated, close-set ridges or lamellae, increasing in size toward the basal margin; posteriorly subangulated; two cardinal teeth, posterior bifid; lateral teeth strongly developed; pallial sinus deep." Clark, 1896.

The question of the identity of this form with *Tellina subtriangularis* Aldrich of the Alabama Eocene has been carefully considered. Dr. Dall[1] agrees with us that they are distinct, but Professor Harris[2] thinks they are the same. *T. williamsi* is more elongate and more strongly sculptured.

Length, 12 mm., height, 7 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek, 2½ miles above Popes Creek, Woodstock. AQUIA FORMATION. Potomac Creek.

Collection.—Maryland Geological Survey, Johns Hopkins University.

TELLINA (PERONIDIA) PAPYRIA (?) Conrad.

(?) *Tellina papyria* Conrad, 1833, Fossil Shells of the Tertiary, No. 4, p. 41 (fig'd. Amer. Jour. Sci., vol. i, 1846, pl. iv, fig. 7).

A single specimen has been found which belongs to neither of the preceding species, and which has the outline of *T. papyria.* The shell is very thin and has almost disappeared.

Length, 35 mm.; height, 26 mm.

Occurrence.—AQUIA FORMATION. Fort Washington.

Collection.—Maryland Geological Survey.

[1] Trans. Wagner Free Inst. Sci., vol. iii, pt. v, 1900, p. 1016.
[2] Bull. Amer. Pal., No. 9, 1897, p. 73.

Family VENERIDAE.

Genus MERETRIX Lamarck.

Meretrix lenis (Conrad).

Plate XXXIII, Fig. 4.

Cytherea lenis Conrad, 1848, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 130, pl. xiv, fig. 19.

Description.—"Longitudinally ovate, thin, ventricose; anterior extremity acutely rounded; posterior end direct, subtruncated; disk with impressed concentric lines, distinct on the sides but obsolete in the middle of the valves; lunule long, cordate, defined by an impressed line; inner margin entire." Conrad, 1848.

This species is distinguished from its associates by its extremely elevated beaks, and deep valves. The shell is very thin and fragile and tends to break along radiating lines. The concentric wrinkles and lines of growth are very distinct toward the beak, but become less so toward the periphery.

Length, 11 mm.; height, 11 mm.

Occurrence.—Nanjemoy Formation. Woodstock, Ravine north of Thrift (?).

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences (No. 6384).

Meretrix ovata var. ovata (Rogers).

Plate XXXIV, Figs. 1, 1a.

Cytherea ovata Rogers, 1837, Trans. Amer. Philos. Soc., vol. v, p. 340; vol. vi, pl. xxvii, fig. 2. (Reprint Geol. of the Virginias, 1884, p. 668, pl. ii, fig. 2.)

Cytherea liciata Conrad, 1848, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 131, pl. xiv, fig. 20.

Cytherea ovata H. C. Lea., 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 99.

Cytherea liciata H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 99.

Meretrix liciata Conrad, 1854, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 30.

Meretrix ovata Conrad, 1854, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 30.

Dione ovata Conrad, 1865, Amer. Jour. Conch., vol. i, p. 6.

Dione liciata Conrad, 1865, Amer. Jour. Conch., vol. i, p. 6.

Dione ovata Conrad, 1866, Smith. Misc. Coll. (200), p. 7.

Dione liciata Conrad, 1866, Smith. Misc. Coll. (200), p. 7.

Cytherea ovata Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5. (In part.)

Cytherea ovata Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 76. (In part.)

Description.—"Shell subovate, somewhat inflated, with concentric transverse striae, very fine near the umbones, but much coarser near the margin; beaks rather elevated; lunule very indistinct; teeth elevated and straight, the two posterior ones of the left valve small, much compressed, approximate, and nearly parallel; the anterior tooth large and grooved by a deep canal; cavity of shell deep; margin entire; posterior margin straight, and separated from the muscular impression by a fold or groove. Length one and one-tenth of an inch; height eighty-five hundredths of an inch." Rogers, 1837.

This widely-distributed species shows great variation in outline and has been described under several names, of which only the Maryland names are given in the synonymy. The complete species includes *M. nuttalliopsis* Heilprin with all its varieties, and a number of other Alabama names.

The species ranges from the base to the summit of the Maryland Eocene, and is very abundant in nearly all localities. The two varieties may be clearly recognized and their separation closely conforms to the stratigraphic divisions.

The form originally described by Rogers comes from the Nanjemoy formation. It is smaller, thinner, in general more elongate, and with a less rounded basal margin than the older type. It was this variety that Conrad afterward named *liciata*.

Length, 31 mm.; width, 24 mm.

Occurrence.—Nanjemoy Formation. East and west of Port Tobacco, Popes Creek, 1 to 2½ miles above Popes Creek, ½ mile below Chapel Point, Upper Marlboro (deep cut near Chesapeake Beach R. R. station), Upper Marlboro (southwest of town near forks of roads), Head of Nanjemoy Creek, 1 mile southeast of Piscataway.

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences, U. S. National Museum.

Meretrix ovata var. pyga Conrad.

Plate XXXIV, Figs. 2, 2a, 3, 3a, 4, 5.

Cytherea pyga Conrad, 1848, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 131, pl. xiv, fig. 18.

Cytherea pyga H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 99.

Meretrix pyga Conrad, 1854, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 30.
Dione pyga Conrad, 1865, Amer. Jour. Conch., vol. i, p. 6.
Cytherea ovata Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5. (In part.)
Cytherea ovata Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 76 (In part), pl. xvi, figs. 1*a*–1*f*.

Description.—" Suboval, ventricose, thick, with closely arranged robust concentric lines; umbo wide, prominent above; dorsal margin very oblique, rounded; posterior extremity obtusely and obliquely rounded inwards; anterior extremity much narrower than the posterior, and more acutely rounded; lunule lanceolate, defined by a distinct impressed line; cardinal teeth robust. Length, $1\frac{3}{8}$; height, $1\frac{1}{4}$." Conrad, 1848.

The form described by Conrad under this name was found in the Aquia formation, and the name as here used is thus restricted. The specimens are large, thick, ventricose, and more nearly oval than the variety from the Nanjemoy formation.

Length, 50 mm.; width, 43 mm.

Occurrence.—Aquia Formation. Potomac Creek, Aquia Creek, Fort Washington, Glymont, Mouth of Paspotansa Creek, Liverpool Point, Sheckel's Farm near South River, Clifton Beach, 2 miles below Potomac Creek, 1 mile northeast of Grimesville, Upper Marlboro, Hardesty, Brooks Estate near Seat Pleasant, 2 miles west of Collington, Reedy Run (branch of Chickomuxen Creek), Mattawoman Creek (?), 1 mile southeast of Mason Springs.

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences, U. S. National Museum.

Meretrix subimpressa Conrad.

Plate XXXIII, Figs. 5, 5a, 6, 7, 8, 8a, 9, 9a.

Cytherea subimpressa Conrad, 1848, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 130, pl. xiv, fig. 26.
Cytherea subimpressa H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 99.
Meretrix subimpressa Conrad, 1854, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 30.
Cytherea subimpressa Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Cytherea subimpressa Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 77, pl. xvii, figs. 1*a*–1*h*.

Description.—" Ovate, slightly ventricose, smooth and polished, with concentric, slightly impressed lines on the anterior side; anterior side

short, rather acutely rounded; posterior side produced, acutely rounded at the extremity; dorsal margin long, oblique, slightly curved; beaks prominent; lunule lanceolate; defined by a slightly impressed line. Length, $1\frac{1}{8}$ inch; height, 8-10 inch." Conrad, 1848.

This species is very abundant in the Woodstock member of the Nanjemoy formation.

Length, 30 mm.; width, 18 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek, 1 mile southeast of Piscataway, Woodstock, Upper Marlboro (southwest of town near forks of two roads).

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences.

Genus DOSINIOPSIS Conrad

DOSINIOPSIS LENTICULARIS (Rogers).

Plate XXXV, Figs. 1a-1g.

Cytherea lenticularis Rogers, 1839, Trans. Amer. Philos. Soc., vol. vi, p. 372, pl. xxviii, fig. 1.
Cytherea lenticularis H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 99.
Artemis lenticularis Conrad, 1853, Proc. Acad. Nat. Sci. Phila., vol. vi, p. 320.
Dosinia lenticularis Conrad, 1854, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 30.
Dosiniopsis meekii Conrad, 1864, Proc. Acad. Nat. Sci. Phila., vol. xvi, p. 213, and figure in text.
Dosiniopsis lenticularis Conrad, 1865, Amer. Jour. Conch., vol. i, p. 6.
Dosiniopsis meekii Conrad, 1865, Amer. Jour. Conch., vol. i, p. 6.
Dosiniopsis meekii Conrad, 1866, Smith. Misc. Coll. (200), p. 6.
Dosiniopsis lenticularis Conrad, 1866, Smith. Misc. Coll. (200), p. 6.
Dosiniopsis lenticularis Harris, 1894, Amer. Jour. Sci., ser. iii, vol. xlvii, p. 302.
Dosiniopsis lenticularis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Dosiniopsis lenticularis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 78, pl. xviii, figs. 1*a*–1*g*.

Description.—" Shell large, depressed, discoidal, rather thick, length nearly equal to the breadth; transversely striated; lunule long, ovate, obscurely defined by a very faint impressed line; umbones rather depressed; beaks small, hardly recurved; teeth straight, divergent; cavity of the shell not deep; margin entire. Diameter about two inches." Rogers, 1839.

The type of the species, as figured and described by Rogers, is a much

less common form than the variety later described by Conrad under the name of *D. meekii*. Rogers's type represents a moderately thin shell with a weak hinge, while the form described by Conrad is a heavy shell with a broad, solid hinge. Every possible gradation between these extremes has been obtained.

Length, 70 mm.; height, 70 mm.

Occurrence.—Aquia Formation. Fort Washington, Glymont, Clifton Beach, Potomac Creek, Liverpool Point, Aquia Creek, Mattawoman Creek, 1 mile northeast of Piscataway, Sheckels Farm near South River, Reedy Run (branch of Chickomuxen Creek), 1 mile west of Hardesty, near Hardesty, Brooks Estate near Seat Pleasant, 1 mile northeast of Grimesville, Harrisons Landing, Upper Marlboro, 3 miles west of Pisgah, Fredericktown.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Family CARDIIDAE.

Genus PROTOCARDIA Beyrich.

Protocardia lenis Conrad.

Plate XXXVI, Figs. 1, 1a, 2, 2a, 3.

Cardium (Protocardia) lenis Conrad, 1855, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 258.

Protocardia virginiana Conrad, 1864, Proc. Acad. Nat. Sci. Phila., vol. xv, p. 211.

Protocardia virginiana Conrad, 1866, Smith. Misc. Coll. (200), p. 6.

Protocardia virginiana Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Protocardia virginiana Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 81, pl. xxvi, figs. 1*a*–1*c*.

Protocardia lenis Dall, 1900, Trans. Wagner Free Inst. Sci., vol. iii, pt. v, p. 1113.

Description.—"Compared with *C. nicolletti;* umbo less inflated, posterior margin oblique, shell proportionally longer, and the radiating lines 22; in the other 25. The posterior cardinal tooth larger, &c." Conrad, 1855.

"Cordate, subtriangular, inequilateral, ventricose, thin; radiating lines minute; anterior upper margin very oblique, slightly emarginate, posterior side slightly produced, the margin obliquely truncated; post-umbonal area densely tuberculated on closely arranged striae; posterior car-

dinal tooth small, tubercular. Height, $1\frac{1}{2}$ inch; length, $1\frac{2}{5}$ inch." Conrad, 1864.

This species has a wide vertical and horizontal range in the Maryland Eocene. It is by no means a common form, and good specimens are very rare.

Certain Gulf-state forms have been referred to this species, but the recent work of Dr. Dall shows that they are distinct and that this species is apparently restricted to Maryland and Virginia.

Length, 42 mm.; width, 42 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek, Woodstock. AQUIA FORMATION. Aquia Creek, Potomac Creek, 1 mile southeast of Mason Springs, 2 miles below Potomac Creek, Upper Marlboro, Rolphs Landing, 1 mile northeast of Piscataway, mouth of Paspotansa Creek.

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences.

Family DIPLODONTIDAE.

Genus DIPLODONTA Bronn.

DIPLODONTA MARLBOROENSIS n. sp.

Plate XXXVI, Fig. 4.

Description.—Shell subcircular, moderately and regularly convex. Beaks depressed, approximate. Lines of growth weak. Surface irregularly wrinkled, sometimes smooth and almost polished.

Differs from *D. hopkinsensis* Clark in being larger, more elevated, much less globose, having a less prominent beak, and much weaker and less frequent lines of growth.

This species has a resemblance to *D. ungulifera* Conrad. The resemblance is especially close with Lea's figure of that species (described as *Egeria rotunda*).

Length, 18 mm.; width, 16 mm.; depth of valve, 4 mm.

Occurrence.—AQUIA FORMATION. Upper Marlboro, Sheckel's Farm near South River.

Collection.—Maryland Geological Survey.

Diplodonta hopkinsensis Clark.

Plate XXXVI, Figs. 5, 5a, 6, 7.

Diplodonta hopkinsensis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Diplodonta hopkinsensis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 79, pl. xxii, figs. 1*a*–1*d*.
Diplodonta hopkinsensis Dall, 1900, Trans. Wagner Free Inst. Sci., vol. iii, pt. v, p. 1181.

Description.—" Shell small, suborbicular, globose; surface with fine indistinct striations; anteriorly and posteriorly rounded." Clark, 1896.

This species has not been found in Maryland, but as it occurs in the same beds in Virginia it will undoubtedly be found in Maryland later, and for this reason the figures and description are reprinted for the benefit of future investigators.

Dr. Dall records several localities in the Chickasawan of Alabama.

Length, 16 mm.; height, 15 mm.

Occurrence.—Nanjemoy Formation. Evergreen, Va.

Collection.—Johns Hopkins University.

Family LUCINIDAE.

Genus LUCINA Bruguière.

Lucina aquiana Clark.

Plate XXXVII, Figs. 1, 1a.

Lucina aquiana Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Lucina aquiana Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 78, pl. xx, figs. 1*a*, 1*b*.
(*?*) *Lucina greggi* Harris, 1897, Bull. Amer. Pal. No. 9, p. 70 (In part), pl. xiv, fig. 2*a* (not fig. 2).

Description.—" Shell of moderate size, somewhat compressed; surface covered with numerous concentric striae; umbones depressed and acuminate on account of prominent, deeply incised lunules; anterior side elongate; posterior side rounded; hinge with two cardinal and two lateral teeth." Clark, 1896.

The smaller figure published by Professor Harris of a specimen from Gregg's Landing, Ala., is indistinguishable from this species.

Length, 18 mm.; height, 18 mm.

Occurrence.—Aquia Formation. Aquia Creek, Upper Marlboro.

Collections.—U. S. National Museum, Maryland Geological Survey.

Lucina astartiformis Aldrich.

Plate XXXVII, Figs. 2, 2a.

Lucina astartiformis Aldrich, 1897, Bull. Amer. Pal. No. 8, p. 15, pl. v, figs. 1, 1*a*.

Description.—" Shell small, rather solid; beak pointed and small; surface with numerous concentric raised lamellae which nearly overlap at ventral margin; between the striae are fine radiating lines from beak to margin; striae terminating at hinge line in raised points; hinge long and narrow; anterior of shell concave along the hinge line; escutcheon smooth; cardinal teeth separated by a deep quadrangular fosset; no laterals; muscular impressions distinct; pallial line simple; posterior part of valves somewhat flattened; margin smooth." Aldrich, 1897.

The number of raised lamellae and the distance between them are very variable factors. This species is very rare.

Length, 6 mm.; width, 5.5 mm.

Occurrence.—Nanjemoy Formation. 1 mile southeast of Piscataway, Upper Marlboro (deep cut near Chesapeake Beach R. R. station).

Collection.—Maryland Geological Survey.

Lucina dartoni Clark.

Plate XXXVII, Figs. 3, 3a, 3b.

Lucina dartoni Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Lucina dartoni Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 79, pl. xx, figs. 2*a*-2*c*.

Description.—" Shell rather small, suborbicular, thin; surface with fine, thin, distant concentric, lamellated striae, crossed by numerous radial, fine, irregular lines less distant than the concentric lamellae; anteriorly and posteriorly high shouldered and angulated; lunules large; hinge area narrow; ligament small; muscle impressions shallow; margin simple." Clark, 1896.

Length, 9 mm.; width, 7.5 mm.

Occurrence.—Nanjemoy Formation. Popes Creek, 2½ miles above Popes Creek, Woodstock.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Lucina uhleri Clark.

Plate XXXVII, Figs. 4, 5, 6, 7.

Lucina uhleri Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Lucina uhleri Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 79, pl. xxi, figs. 1*a*–1*d*.
(?) *Lucina ulrichi* Harris, 1897, Bull. Amer. Pal. No. 9, p. 71, pl. xiv, fig. 4.

Description.—"Shell small, orbicular, slightly tumid; surface with numerous uniform, elevated, concentric ridges; anterior and posterior sides rounded; lunules slightly depressed; interior with radiating striae; margin simple." Clark, 1896.

The original figures of this species did not show the muscular scars and the teeth accurately. The figures here published correct these defects.

It is evident that Professor Harris has spelled the name *ulrichi* unintentionally. The form from Wood's Bluff is probably the same as that from Maryland. The apparent difference in the hinge, noted by Professor Harris being an inaccuracy in the old figures which are here replaced by a correct one. It would be a misfortune if we had to use two names, as nearly alike as *uhleri* and *ulrichi*, for two forms with as slight differences as these show.

This is the most abundant and widely distributed of our Maryland Eocene Lucinas.

The types are immature.

Length, 9 mm.; height, 8 mm.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock. Aquia Formation. Clifton Beach, Upper Marlboro, Potomac Creek, Glymont, 1 mile northeast of Piscataway, Mattawoman Creek, 1 mile southeast of Mason Springs, 2 miles below Potomac Creek, Liverpool Point.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Lucina whitei Clark.

Plate XXXVII, Figs. 8, 8a, 9.

Lucina whitei Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Lucina whitei Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 79, pl. xx, figs. 3*a*–3*c*.

Description.—"Shell small, suborbicular, globose; surface with prominent concentric lamellae, interrupted posteriorly by shallow fold, extend-

ing from umbones to posterior basal margin; lunules deeply depressed; anterior side high shouldered, rounded; posterior high shouldered, angulated; margin crenulated." Clark, 1896.

Length, 8 mm.; width, 7.5 mm.

Occurrence.—NANJEMOY FORMATION. West of Port Tobacco, ½ mile below Chapel Point, Woodstock.

Collections.—Johns Hopkins University, Maryland Geological Survey.

LUCINA sp.

A single fragment, evidently of a large *Lucina*, was found, which is very different from any other form known from Maryland or Virginia. It probably belongs to a new species of *Lucina*, or to *L. claibornensis* Con.; but our only specimen is too imperfect to determine. The shell is fragile, moderately thin, and the valves very shallow. It has about forty, rugose, concentric lamellae with faint, wavy, radiating lines between them. Hinge, scars, and pallial line are unknown. Length and height about 30 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek.

Collection.—Maryland Geological Survey.

Family CARDITIDAE.

Genus VENERICARDIA Lamarck.

This genus is very abundantly represented in the Maryland Tertiary and especially in the Eocene. The Eocene forms are very numerous and range throughout the entire horizontal and vertical extent of the formations. The variation in form is very great and has led to the establishment of several species and varieties, all of which have been referred by most later authors to *V. planicosta*. Three forms, possessing constant differences, may be recognized, and as these are each definitely restricted in stratigraphic range, and are hence of geologic value, they are given names.

Rogers[1] described from Virginia a species of *Venericardia* which he called *V. ascia*. As this form has never been recognized from Mary-

[1] Trans. Amer. Philos. Soc., vol. vi, 1839, p. 374, pl. 29, fig. 2.

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land, no reference is made to it in the synonymy. If the figure and description are correct, it is probably a different species from any in Maryland.

Venericardia planicosta var. regia Conrad.

Plate XXXVIII, Figs. 1, 1a; Plate XXXIX, Figs. 1, 1a; Plate XL, Figs. 1, 2, 3.

Cardita planicosta Conrad, 1832, Fossil Shells of the Tertiary, No. 1, [1st. edit.] p. 20, pl. v, fig. 2.

Cardita planicosta Morton, 1834, Syn. Org. Rem. Cretaceous Group, App., p. 7.

Venericardia planicosta H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 107.

Venericardia planicosta var. regia Conrad, 1865, Amer. Jour. Conch., vol. i, p. 8.

Venericardia planicosta Conrad, 1866, Smith. Misc. Coll. (200), p. 5.

Venericardia regia Conrad, 1866, Smith. Misc. Coll. (200), p. 5.

Cardita planicosta Heilprin, 1884, Contrib. Tert. Geol. and Pal., p. 87.

Venericardia planicosta var. regia Harris, Amer. Jour. Sci., ser. iii, vol. xlvii, p. 302.

Venericardia planicosta Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Venericardia planicosta Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 80, pl. xxi, fig. 3; pl. xxii, fig. 2; pl. xxiii, figs. 1*a* (?) 1*b* (?) 1*c*; pl. xxiv, figs. 1*a* (?) 1*b* (?) 1*c*; pl. xxv, figs. 1*a*–1*c*.

Description.—The form originally described and figured by Conrad, which he subsequently called *V. regia*, seems to correspond very closely to the original *V. planicosta* of Europe. Conrad describes it as follows: "Cordate; ribs about 22, broad and flattened, separated by a narrow groove which becomes obsolete at the base; ribs near the posterior end narrow, indistinct, and crossed by numerous strong wrinkles; lunule small; cordate, profoundly impressed; inner margin crenate." Conrad, 1832.

This form is the largest of our Eocene Venericardias and is widely distributed in and restricted to the Aquia formation. It is readily distinguished by its size, and its broad, flat ribs, which do not become obsolete.

Length, 110 mm.; width, 100 mm.

Occurrence.—Aquia Formation. Upper Marlboro, 1 mile west of Hardesty, Sheckels Farm near South River, 1 mile northeast of Piscataway, Near Annapolis, Aquia Creek, Potomac Creek, Collington, Rolphs Landing, Mouth of Paspotansa Creek, Fredericktown (Cecil

County), Fort Washington, South River at mouth of Broad Creek, Severn River, Piscataway (Conrad's original locality), 2 miles below Potomac Creek.

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences, Johns Hopkins University, U. S. National Museum.

VENERICARDIA MARYLANDICA n. sp.

Plate XL, Figs. 7, 7a.

Description.—Shell thin; outline circular; valves shallow; about 27 ribs, broad and flat on top, with deep, narrow interspaces near the beaks, but very flat, and separated by narrow, impressed line toward the periphery.

This species resembles very closely in outline *V. pectuncularis* from the Paris Basin. It is restricted to the Woodstock substage.

Length, 80 mm.; width, 80 mm.

Occurrence.—NANJEMOY FORMATION. 2 and 2½ miles above Popes Creek, Popes Creek, Woodstock.

Collection.—Maryland Geological Survey.

VENERICARDIA POTAPACOENSIS n. sp.

Plate XL, Figs. 4, 5, 5a, 6, 6a.

Description.—Shell small, very thick; valves relatively deep, and elongate along the line of the beak and posterior basal margin; beak anteriorly situated; lines of growth strong; ribs 20 to 24 in number, elevated and crenulated toward the beak, and obsolete toward the periphery; lunule deeply impressed; muscular scars deeply impressed; margin strongly crenulate.

This form is restricted to the Nanjemoy formation, and is most typically developed in the lower or Potapaco substage. Figure 4 represents the typical Potapaco form, Figures 5 and 6 show the Woodstock form.

Length, 40 mm.; width, 33 mm.

Occurrence.—NANJEMOY FORMATION. East and west of Port Tobacco, Popes Creek, Woodstock, ½ mile below Chapel Point, Head of Nanjemoy

Creek, Potomac Creek (50 feet from top of bluff), 1 mile southeast of Piscataway, La Plata, Upper Marlboro (gully southwest of town), 2 and 2½ miles above Popes Creek.

Collections.—Maryland Geological Survey, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Family CRASSATELLITIDAE.

Genus CRASSATELLITES Kruger.

CRASSATELLITES ALAEFORMIS (Conrad).

Plate XLI, Figs. 1-8.

Crassatella alaeformis Conrad, 1830, Jour. Acad. Nat. Sci. Phila., vol. vi, p. 228, pl. x, fig. 1.

Crassatella alaeformis Morton, 1834, Syn. Org. Rem. Cretaceous Group, App., p. 7.

Crassatella capri-cranium Rogers, 1839, Trans. Am. Phil. Soc., new series, vol. vi, p. 375, pl. xxx, fig. 2. (Reprint: Geology of the Virginias, 1884, p. 672, pl. v, fig. 2.)

Crassatella alaeformis Conrad, 1846, Amer. Jour. Sci., ser. ii, vol. i, p. 396, pl. iii, fig. 3.

(?) *Crassatella palmula* Conrad, 1846, Amer. Jour. Sci., ser. ii, vol. i, p. 396, pl. iv, fig. 1.

Crassatella alaeformis H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 98.

Crassatella capri-cranium H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 98.

Crassatella alaeformis d'Orbigny, 1850, Prodrome, vol. ii, p. 383.

Crassatella capri-cranium Conrad, 1865, Amer. Jour. Conch., vol. i, p. 10.

Crassatella alaeformis Conrad, 1865, Amer. Jour. Conch., vol. i, p. 10.

Crassatella alaeformis Conrad, 1866, Smith. Misc. Coll. (200), p. 5.

Crassatella capri-cranium Conrad, 1866, Smith. Misc. Coll. (200), p. 5.

Crassatella declivis Heilprin, 1880, Proc. U. S. Nat. Museum, vol. iii, pp. 151, 152, pl. facing p. 150, fig. 9.

Crassatella protexta de Gregorio, 1890, Ann. Géol. et Pal., pl. xxv, fig. 12.

Crassatella alaeformis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Crassatella alaeformis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 81, pl. xxvii, figs. 1*a*–1*k*.

(?) *Crassatella palmula* Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 93.

Crassatella declivis Aldrich, 1897, Bull. Amer. Pal. No. 8, p. 4, pl. iii, figs. 1, 1*a*.

Description.—" Shell transversely ovate oblong; anterior side rostrated; posterior side short and rounded; umbones transversely sulcated; margin slightly crenulated within." Conrad, 1830.

The variations in *C. alaeformis* Conrad are so great that in the absence of connecting forms one would be led to consider the existence of several well-defined species. After a careful study of a large amount of

material belonging to this important species, it appears that the forms figured and described by Rogers and Heilprin as distinct species are only varieties of Conrad's *C. alaeformis.* The species is largely represented in the lower portion of the Middle Atlantic Coast series, especially in the Piscataway substage of the Aquia formation. It is rarer in the Paspotansa substage, and here two distinct forms are found, each different from the older forms. The specimens from the sandy beds along the Potomac are small and very elongate, the average size being 40 x 20 mm. The indurated ledge at Upper Marlboro, Hardesty, South River bridge, and Rolphs Landing contains a very large form at the other end of the *alaeformis* series. This reaches the size and proportions of 90 x 60 mm., but a single specimen from South River, which may however belong to another species, attains the size of 95 x 80 mm. The larger elongate forms approach the several Miocene species in size and outline. The specimens from the various beds of the Piscataway substage vary greatly in size and form and connect the Paspotansa varieties with each other and almost connect them with *C. aquiana. C. palmula* Conrad probably belongs in this series.

Length, 40 to 90 mm.; height, 20 to 60 mm.

Occurrence.—Aquia Formation. Paspotansa Creek, 2 miles below Potomac Creek, Potomac Creek, 1 mile southeast of Mason Springs, Clifton Beach, Glymont, Mattawoman Creek, Liverpool Point, Wades Bay, Aquia Creek, 1 mile northeast of Piscataway, Brooks Estate near Seat Pleasant, Fort Washington, Upper Marlboro, 3 miles west of Leeland on Western Branch, West of Collington, between Buena Vista and Collington, Sheckel's Farm near South River, Rolphs Landing.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Crassatellites aquiana (Clark).

Plate XLII, Figs. 1, 2a, 2b.

Crassatella aquiana Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Crassatella aquiana Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 82, pl. xxvi, figs. 2a–2c.

Description.—"Shell moderately large, attenuated posteriorly; surface with a few broad, shallow, concentric furrows, indicating periods of

growth, and fine concentric lines, often obscure; lunules broad, deeply depressed.

"This species differs from *C. alaeformis* by its shorter, broader posterior extremity; by the absence of deep, prominent furrows on the umbones, and by the umbones themselves being higher." Clark, 1896.

This species shows considerable variation in size and form, sometimes approaching the more elevate varieties of *C. alaeformis*. On the other hand it frequently becomes so short and elevate as to approach *Astarte* in outline. This species is most abundant in the Piscataway substage.

Length, 60 mm.; height, 50 mm.

Occurrence.—Aquia Formation. Aquia Creek, Glymont, Reedy Run, Brooks Estate near Seat Pleasant, Potomac Creek, Liverpool Point, Mattawoman Creek.

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences.

Crassatellites alta (Conrad).

Plate XLII, Fig. 3.

Crassatella alta Conrad, 1832, Fossil Shells of the Tertiary, No. 2, p. 21, pl. vii.
Crassatella alta Conrad, 1835, Trans. Geol. Soc. Penn., vol. i, p. 335.

Description.—"Suboval, thick and ponderous, compressed; anterior margin obtusely rounded; posterior margin broad and slightly angular; beaks with regular concentric grooves, and somewhat angulated behind; inner margin crenulated." Conrad, 1832.

Conrad recorded this species from Upper Marlboro in 1835, but there is no other evidence of its occurrence at that locality. The large specimen here figured is from Hardesty and can belong to no other known species. The large forms alluded to under *C. alaeformis* may be the same as the Upper Marlboro forms which Conrad referred to *C. alta*.

Length (of fragment), 105 mm.; width, 75 mm.

Occurrence.—Aquia Formation. Hardesty.

Collection.—Maryland Geological Survey.

CRASSATELLITES sp.

Plate XLII, Figs. 4, 4a.

The specimen figured possesses characters very different from any other known species of the genus and if normal must be new, although it is perhaps only a diseased specimen of *C. alaeformis*.

Length, 20 mm.; width, 13 mm.

Occurrence.—AQUIA FORMATION. Clifton Beach.

Collection.—Johns Hopkins University.

Family ASTARTIDAE.

Genus ASTARTE Sowerby.

ASTARTE MARYLANDICA Clark.

Plate XLII, Fig. 5.

Astarte marylandica Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Astarte marylandica Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 80, pl. xxi, fig. 2.

Description.—"Shell small, roundedly trigonal, somewhat compressed, thick, nearly equilateral; surface concentrically costated and with superimposed fine striae; umbones prominent." Clark, 1896.

Length, 16 mm.; width, 15 mm.

Occurrence.—AQUIA FORMATION. Upper Marlboro, Brooks Estate near Seat Pleasant, Sheckel's Farm near South River.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Family PLEUROPHORIDAE.

Genus CORALLIOPHAGA Blainville.

Subgenus ORYCTOMYA Dall.

CORALLIOPHAGA (ORYCTOMYA) BRYANI Clark.

Plate XLIII, Figs. 1, 1a, 2, 2a.

Coralliophaga bryani Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Coralliophaga bryani Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 73, pl. xv, figs. 2*a*, 2*b*.

Description.—"Shell transversely oblong, thin, slightly gaping posteriorly; prominent fold from umbo to lower margin; surface with deli-

cate lines of growth and fine radial rows of minute granules, obsolete over much of the surface; teeth consisting of two small cardinal and one long posterior lateral; pallial line with shallow sinus." Clark, 1896.

Only two specimens, both right valves, have been found. The one here newly figured is smaller than the type, but more nearly perfect. The teeth are not well preserved, but the radiating rows of granules show the generic affinities.

Length, 20 mm.; height, 16 mm.

Occurrence.—Aquia Formation. 1 mile southeast of Mason Springs, Pomonkey Neck.

Collections.—Maryland Geological Survey, U. S. National Museum.

Order ANOMALODESMACEA.

Family PERIPLOMIDAE.

Genus PERIPLOMA Schumacher.

Periploma (?) sp.

Two specimens have been found which have the general form of this genus, but are too imperfect for complete identification or description.

Length, 29 mm.; height, 24 mm.

Occurrence.—Nanjemoy Formation. East of Port Tobacco, Woodstock.

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences (No. 6430).

Family PHOLADOMYIDAE.

Genus PHOLADOMYA Sowerby.

Pholadomya marylandica Conrad.

Plate XLIII, Fig. 3.

Pholadomya marylandica Conrad, 1842, Proc. Nat. Inst. Bull. ii, p. 193, pl. i, fig. 3.
Pholadomya marylandica Conrad, 1846, Amer. Jour. Sci., ser. ii, vol. i, p. 214, pl. ii, fig. 9.
Pholadomya marylandica H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 104.
Pholadomya marylandica Conrad, 1865, Amer. Jour. Conch., vol. i, p. 3.
Pholadomya marglandica Conrad, 1866, Smith. Misc. Coll. (200), p. 8.
Pholadomya marylandica Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Pholadomya marylandica Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 75, pl. xxix, fig. 2.

Description.—" Ovate, profoundly ventricose, with coarse, irregular concentric lines and furrows, and obsolete, rather distant, radii; summit of umbo prominent." Conrad, 1842.

The very fragile shell of this species was found only partially preserved in a few instances, although numerous casts were obtained from the indurated layer, Zone 5, at Aquia Creek.

Length, 75 mm.; height, 55 mm.

Occurrence.—Aquia Formation. Clifton Beach (upper indurated bed), Aquia Creek, Fort Washington, Piscataway (Conrad).

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences, Johns Hopkins University, U. S. National Museum.

Order PRIONODESMACEA.

Family MYTILIDAE.

Genus MODIOLUS Lamarck.

Modiolus alabamensis Aldrich.

Plate XLIII, Figs. 4, 5, 5a.

Modiola alabamensis Aldrich, 1895, Bull. Amer. Pal. No. 2, p. 16, pl. v, fig. 13.
Modiola potomacensis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Modiola potomacensis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 85, pl. xxxiv, figs. 1*a*–1*c*.
Modiolus (*Brachydontes*) *potomacensis* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iii, p. 796.

Description.—" Shell strongly arcuate, surface with raised lines closely set, becoming nearly obsolete on the beaks; a few lines of growth crossing the striae; beak small, hinge margin slightly curved, ascending; very small fissure on basal margin." Aldrich, 1895.

Shell small, oblong, thin, tumid, anterior side somewhat contracted; surface with fine costated striae nearly obsolete anteriorly and less strongly accentuated posteriorly than in the center, crossed occasionally by irregular lines of growth; umbones prominent, curved.

Length, 32 mm.; width, 15 mm.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock, 2½ miles above Popes Creek. Aquia Formation. Liverpool Point, Clif-

ton Beach, Wades Bay, Aquia Creek (Zones 2 and 3), Potomac Creek, 2 miles below Potomac Creek, Glymont, 1 mile southeast of Mason Springs, Upper Marlboro, Fort Washington, Mouth of Paspotansa Creek.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Modiolus marylandicus n. sp.

Plate XLIII, Fig. 6.

Description.—Shell thin and fragile; beaks elevated, strongly incurved, and situated far back of the anterior extremity; surface marked by strong lines of growth and faint radiating lines, developing into strong radial cracks.

One specimen only, and that showing parts of both valves, has been found; while another that may belong to this species, although it shows some quite different characteristics, was also obtained.

Length (of fragment), 20 mm.; width, 10 mm.

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Maryland Geological Survey.

Genus LITHOPHAGA Bolten.

Lithophaga marylandica n. sp.

Plate XLIII, Fig. 7.

Solemya petricoloides Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Solemya petricoloides Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 74.
Not *Byssomya petricoloides* Lea.

Description.—"Shell elongated, very inequilateral, slightly gaping, thin; surface nearly smooth with fine lines of growth; umbones very posteriorly situated; hinge edentulous; pallial line obscure." Clark, 1896.

Our specimens differ from *petricoloides* in having the beaks nearly terminal.

Length, 11 mm.; width, 4.5 mm.

Occurrence.—Aquia Formation. Clifton Beach.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Family ANOMIIDAE.

Genus ANOMIA Müller.

ANOMIA MARYLANDICA n. sp.

Plate XLIV, Figs. 2, 2a, 3.

Description.—Shell small, thin, irregular; valves very unequal; right valve moderately and uniformly convex; byssal opening small; left valve very convex and irregular. Beak anteriorly situated and much incurved. Surface marked by fine raised radiating threads and irregular wavy concentric undulations. Lines of growth strong, irregular.

Length, 19.5 mm.; height, 18 mm.

Occurrence.—NANJEMOY FORMATION. Woodstock, Popes Creek. AQUIA FORMATION. Clifton Beach.

Collection.—Maryland Geological Survey.

ANOMIA McGEEI Clark.

Plate XLIV, Figs. 1, 1a.

(?) *Anomia ruffini* Conrad, 1835, Fossils Medial Tertiary, p. 74, pl. xlii, fig. 6.
Anomia mcgeei Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Anomia mcgeei Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 86, pl. xxxiv, figs. 5*a*, 5*b*.
(?) *Anomia ruffini* Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 93.
Anomia ruffini Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 782. (In part).

Description.—" Shell of left valve rather solid, convex, nearly equilateral; surface strongly lamellar, with faint radial plaits, stronger in the latter than in the earlier portions of the shell." Clark, 1896.

The type of this species, which is the only adult specimen known, was found in the collections of the Philadelphia Academy of Natural Sciences labelled " Eocene of Hanover County, Va." *Anomia ruffini* Conrad was described with Miocene fossils (the type having been found on the Pamunkey River, Virginia, where both Eocene and Miocene strata occur), and, was later, by Conrad and by others, placed in lists of both Eocene and Miocene forms. It is extremely doubtful if the species has ever been found in the Eocene.

The resemblance between *A. mcgeei* and *A. ruffini* is so close and both are so different from any other forms which have ever been found

in the Eocene that it is possible that they both represent the same Miocene species. Dr. Dall considers them identical but is in doubt as to the horizon from which they came.

It seems best to publish here the original figures of *A. mcgeei* under the original name in order to bring the question before the eyes of future investigators.

Length, 50 mm.; height, 48 mm.

Occurrence.—Hanover County, Va.

Collection.—Philadelphia Academy of Natural Sciences.

Family PECTINIDAE.

Genus PECTEN Müller.

PECTEN CHOCTAVENSIS Aldrich.

Plate XLIV, Figs. 4, 5, 6.

Pecten choctavensis Aldrich, 1895, Bull. Amer. Pal. No. 2, p. 16, pl. v, fig. 7.

Description.—"Shell suborbicular thin, depressed, finely closely ribbed, ribs showing through the substance of the shell, imbricated near the ventral margin and on the anterior slope; ears ribbed and ribs imbricated with fine oblique reticulations between." Aldrich, 1895.

There are 40 to 50 ribs, which are lamellated, especially when old, but sometimes when very young. The young shells from Alabama do not show any lamellation. The ribs increase both by bifurcation and intercolation. Camptonectes structure is a constant characteristic.

Width, 23 mm.; height, 24 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek, 1½ miles above Popes Creek. AQUIA FORMATION. Upper Marlboro, 1 mile northeast of Piscataway, South East Creek (1 mile from Chester River).

Collection.—Maryland Geological Survey.

PECTEN DALLI Clark.

Plate XLIV, Figs. 7, 7a, 7b.

Pecten rogersi Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Pecten rogersi Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 85, pl. xxxiv, figs. 2a–2c.
Pecten dalli Clark, 1898, Johns Hopkins Univ. Circ., vol. xviii, p. 18.
Pecten (Pseudamusium) frontalis Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 753.
Not *Pecten rogersi* Conrad.

Description.—" Shell small, orbicular, subpellucid, nearly equilateral, thin; surface shining with fine, delicate concentric lines and rather obscure, in places obsolete, radial ribs that show most strongly near the anterior margins; umbones approximate and acute; auricles very unequal and costated." Clark, 1896.

This very beautiful species shows some points of similarity to *P. calvatus* Conrad in form and surface features, but the radial striae are lacking upon the latter. It differs from *P. choctavensis* in its feebler sculpture. It possesses a faint camptonectes structure.

Width, 16 mm.; height, 18 mm.

Occurrence.—NANJEMOY FORMATION. Woodstock, Upper Marlboro (deep cut near Chesapeake Beach R. R. station). AQUIA FORMATION. Potomac Creek, South East Creek (1 mile above Chester River).

Collections.—Johns Hopkins University, Maryland Geological Survey.

PECTEN JOHNSONI Clark.

Plate XLIV, Figs. 8, 8a.

Pecten johnsoni Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Pecten johnsoni Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 85, pl. xxxiv, figs. 3*a*, 3*b*.

Description.—" Shell small, suborbicular, equilateral; surface with about twenty uniform, distant, rounded costate, separated by broad interspaces, with a few short costae at basal margin, the whole crossed by fine lines of growth; ears prominent, unequal." Clark, 1896.

P. greggi Harris resembles this form very closely. It differs in having stronger camptonectes structure, and in not having the number of ribs increase toward the periphery.

Width, 14 mm.; height, 15 mm.

Occurrence.—NANJEMOY FORMATION. Woodstock. AQUIA FORMATION. 2 miles below Potomac Creek, Potomac Creek, Mouth of Paspotansa Creek.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Pecten sp.

Plate XLIV, Figs. 9, 9a.

Pecten sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Pecten sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 86, pl. xxxiv, fig. 4.

Description.—"Shell small, orbicular; surface with about twenty broad, flat costae, dividing in most cases in passing downward, so that over thirty appear at the margin; umbones compressed; ears unequal." Clark, 1896.

This differs from *P. johnsoni* only in having the ribs increase by bifurcation instead of intercolation, and in having the ribs broader than the interspaces. As the figured specimen is the only one that has been found and is very immature it is best not to give it a name. Perhaps it is an aberrant or immature form of *P. johnsoni*, or of *P. wahtubbeanus* Dall.

Width, 10 mm.; height, 11 mm.

Occurrence.—Aquia Formation. Potomac Creek.

Collection.—Maryland Geological Survey.

Family OSTREIDAE.

Genus OSTREA Linné.

Ostrea compressirostra Say.

Plates XLV, XLVI, XLVII.

Ostrea compressirostra Say, 1824, Jour. Acad. Nat. Sci. Phila., vol. iv, p. 132, pl. viii, figs. 2*a*, 2*b* [Reprint Bull. Amer. Pal. No. 5, p. 38, pl. viii, figs. 2*a*, 2*b*.]
Ostrea compressirostra Morton, 1834, Syn. Org. Rem. Cretaceous Group, App., p. 2.
Ostrea sinuosa Rogers, 1837, Trans. Amer. Philos. Soc., vol. v, p. 340; vol. vi, pl. xxvii, fig. 1.
Ostrea compressirostra H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 103.
Ostrea bellovacina Conrad, 1842, Proc. Nat. Inst., Bull. ii, p. 172 (not of Lamarck).
Ostrea sinuosa H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 103.
Ostrea compressirostra Conrad, 1865, Amer. Jour. Conch., vol. i, p. 15.
Ostrea sinuosa Conrad, 1865, Amer. Jour. Conch., vol. i, p. 15.
Ostrea compressirostra Conrad, 1866, Smith. Misc. Coll. (200), p. 3.
Ostrea compressirostra Heilprin, 1883, White's Fossil Ostreidae; Fourth Ann. Rept. U. S. Geol. Survey, p. 309, pl. lxv, figs. 1, 2.
Ostrea compressirostra Heilprin, 1884, Contrib. Tert. Geol. and Pal., p. 85.
Ostrea sinuosa Rogers, 1884, Geology of the Virginias, p. 668, pl. ii, fig. 1.
Ostrea compressirostra de Gregorio, 1890, Ann. Géol. et Pal., t. ii, p. 177, pl. xx, figs. 1, 8.

Ostrea compressirostra Harris, 1894, Amer. Jour. Sci., ser. iii, vol. xlvii, p. 302.
Ostrea compressirostra Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Ostrea compressirostra Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 86, pl. xxxvii, figs. 1, 2*a*–2*c*; pl. xxxviii, figs. 1*a*, 1*b*, 2*a*–2*c*; pl. xxxix, figs. 1, 2*a*, 2*b*: pl. xl, fig. 1.
Ostrea compressirostra Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 679.

Description.—"*Shell* sinistral, subovate: *inferior valve* convex, with numerous convex ribs interrupted by fornicated scales at the lines of increment; *hinge* curving a little upward, very much contracted and short: *superior valve* flat, wrinkled concentrically, without any appearance of longitudinal lines: *hinge* more dilated than that of the superior valve, and oblique with respect to the thickness of the shell." Say, 1824.

This is one of the most abundant fossils in the Aquia formation. The Nanjemoy formation contains many small oysters which are probably the young of *sellaeformis*, although they cannot be distinguished from the young of this species.

Length, 215 mm.; width, 180 mm.

Occurrence.—Aquia Formation. Upper Marlboro, Hardesty, Aquia Creek, Brooks Estate near Seat Pleasant, 3 miles west of Leeland on Western Branch, Sheckel's Farm near South River, Reedy Run, Liverpool Point, 1½ miles south of Grimesville, Potomac Creek, Fort Washington, Tinkers Creek, 1 mile northeast of Piscataway, Swan Creek (ravine near Piscataway Creek), 1 mile southeast of Mason Springs, Mouth of Paspotansa Creek, Wades Bay, 3 miles west of Pisgah, Clifton Beach, Mattawoman Creek, 2 miles south of South River, Glymont, 2 miles below Potomac Creek, Leeland, Seven River.

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Ostrea compressirostra var. alepidota Dall.

Ostrea compressirostra var. alepidota Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, part iv, p. 680.

Description.—"Without raised lamellae externally but with radial grooves." Dall, 1898.

Shell small, roughly triangular; beak high, in some cases slightly twisted; raised lamellae absent or confined to the extreme periphery; radial grooves, becoming stronger toward the periphery.

Length, 85 mm.; width, 65 mm.

Occurrence.—AQUIA FORMATION. Fort Washington, Aquia Creek.

Collections.—Maryland Geological Survey, U. S. National Museum, Philadelphia Academy of Natural Sciences.

OSTREA SELLAEFORMIS Conrad.

Plates XLVIII, XLIX.

Ostrea sellaeformis Conrad, 1832, Fossil Shells of the Tertiary, No. 2, p. 27, pl. xiii, fig. 2.

Ostrea sellaeformis Morton, 1834, Syn. Org. Rem. Cretaceous Group, App., p. 6.

Ostrea sellaeformis Conrad, 1842, Proc. Nat. Inst., Bull. ii, pp. 192, 193, pl. i, fig. 1.

Ostrea sellaeformis H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 103.

Ostrea sellaeformis Conrad, 1865, Amer. Jour. Conch., vol. i, p. 15.

Ostrea sellaeformis Conrad, Smith. Misc. Coll. (200), p. 3.

Ostrea sellaeformis Heilprin, 1883, White's Fossil Ostreidae; Fourth Ann. Rept. U. S. Geol. Survey, p. 311, pl. lxii, figs. 1, 2; pl. lxiii, fig. 1.

Ostrea sellaeformis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Ostrea sellaeformis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 87, pl. xxxv, figs. 1*a*–1*d*; pl. xxxvi, figs. 1*a*, 1*b*.

Description.—"Oblong, convex, thick and ponderous, lobed; one side of the larger valve profoundly sinuous and the opposite side gibbous; smaller valve sinuous and little convex; dorsal margin long and slightly arched, with both extremities obtusely rounded." Conrad, 1833.

This form although very abundantly and characteristically developed in the valleys of the James and Pamunkey rivers, occurs generally in the Potomac Valley and farther north only as small specimens, almost indistinguishable from the young of *O. compressirostra*.

Height, 60 mm.; width, 40 mm. (largest Maryland specimen).

Occurrence.—NANJEMOY FORMATION. Popes Creek, 1½ miles above Popes Creek, 2½ miles above Popes Creek, East of Port Tobacco, Upper Marlboro (deep cut near Chesapeake Beach R. R. station), Woodstock.

Collections.—Johns Hopkins University, Philadelphia Academy of Natural Sciences, Maryland Geological Survey.

Subgenus GRYPHAEOSTREA Conrad.

Ostrea (Gryphaeostrea) vomer (Morton).

Plate L, Figs. 1, 1a, 1b, 2, 3, 4, 4a, 5.

Gryphaea vomer Morton, 1830, Jour. Acad. Nat. Sci. Phila., vol. vi (1st series), p. 83.
Gryphaea vomer Morton, 1834, Syn. Org. Rem. Cretaceous, p. 54, pl. ix, fig. 5.
Gryphaea vomer Conrad, 1835, Trans. Geol. Soc. Penn., vol. i, p. 336.
Gryphaea vomer Conrad, 1842, Proc. Nat. Inst., Bull. ii, p. 172.
Ostrea (*Gryphaeostrea*) *subeversa* Conrad, 1865, Amer. Jour. Conch., vol. i, p. 15 (name only).
Ostrea sp. Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 6.
Ostrea sp. Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 88, pl. xxxix, figs. 3*a*–3*c*.
Ostrea subeversa Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 93.
Ostrea (*Gryphaeostrea*) *subeversa* Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 681.

Description.—" Oblong-oval, thin, narrow; lower valve deep, longitudinally curved; beak prominent, curved laterally; upper valve small in proportion to the lower, and marked with distinct, concentric, squamose plates." Morton, 1834.

The possible equivalence of this form with *Gryphaea vomer* Morton, or *Gryphaea eversa* Mellville was suggested by Dall. Conrad recorded the species from Piscataway and Upper Marlboro.

Length, 39 mm.; width, 20 mm.; depth of lower valve, 10 mm.

Occurrence.—Nanjemoy Formation. ½ mile below Chapel Point. Aquia Formation. Piscataway, Upper Marlboro, Aquia Creek, Potomac Creek, 2 miles below Potomac Creek, Sheckel's Farm near South River, Fredericktown, Glymont.

Collections.—Maryland Geological Survey, Johns Hopkins University, Philadelphia Academy of Natural Sciences.

Genus GRYPHAEA Lamarck.

Gryphaea vesicularis Lamarck.

Plate L, Figs. 6, 6a.

Gryphaea vesicularis Lamarck, 1806, Ann. Mus. viii, p. 160, pl. xxii, fig. 3. An. Sans. Vert., vol. vi, p. 209.

A single specimen of this form was found associated with Eocene fossils at Clifton Beach. It is very perfect, having both valves in position. It seems hardly possible, however, that it can be a representative

of the Eocene fauna, as an isolated specimen of this typical Cretaceous species, it seems more probable that it must have been derived from Cretaceous deposits. An even more remarkable occurrence is the discovery of many specimens of *Terebratula harlani* under similar conditions (see p. 204).

Occurrence.—AQUIA FORMATION. Clifton Beach.

Collection.—Maryland Geological Survey.

Family PTERIIDAE.

Genus PTERIA Scapoli.

PTERIA LIMULA (Conrad).

Plate LI, Fig. 1.

Avicula limula Conrad, 1833, Fossil Shells of the Tertiary, No. 4, p. 39.

Description.—"Shell convex, with slight concentric undulations; umbo tapering gradually towards the apex, which is acute, but not prominent; wings large and very oblique; sinus of the posterior margin not profound; nacre very pearly and iridescent. Height, 1¼ inches." Conrad, 1833.

Height of largest fragment, 18 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek, Hills Bridge. AQUIA FORMATION. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family ARCIDAE.

Genus GLYCYMERIS Da Costa.

GLYCYMERIS IDONEUS (Conrad).

Plate LI, Figs. 2, 2a, 3, 3a, 4.

Pectunculus idoneus Conrad, 1833, Fossil Shells of the Tertiary, No. 4, p. 39.

Pectunculus idoneus Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Pectunculus idoneus Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 84, pl. xxix, figs. 1*a*–1*c*, 2.

Description.—"Shell suborbicular, thick, convex; oblique, with rather obscure radiating striae, and very minute, intervening lines; umbo convex; beaks distant, rather prominent and pointed; cardinal teeth large;

truncated in the center by a rectilinear line; cavity capacious; margin crenate. Length, 1¼ in." Conrad, 1833.

Shell moderately thick, obliquely orbicular, rather ventricose, slightly inequilateral, equivalve, with faint radiations; hinge with few prominent teeth; margins crenulated; beaks depressed.

The higher beds of the Aquia formation, especially the indurated ledge at Upper Marlboro and at the localities to the northeast, are very rich in shells of *Glycymeris*. Although in some features they at times show slight variations from *G. idoneus* of the Gulf, the differences are too slight to warrant specific distinction.

Length, 60 mm.; height, 60 mm.

Occurrence.—NANJEMOY FORMATION. 3 miles above Popes Creek, Woodstock. AQUIA FORMATION. Upper Marlboro, 1 mile west of Hardesty, Potomac Creek, 1 mile northeast of Piscataway, Hardesty, Sheckels Farm near South River, 2 and 3 miles south of South River, Rolph's Landing.

Collections.—Philadelphia Academy of Natural Sciences, Johns Hopkins University, Maryland Geological Survey.

Family LIMOPSIDAE.

Genus TRIGONOARCA Conrad.

TRIGONOARCA DECISA (Conrad) VAR.

Plate LI, Figs. 5, 5a.

Pectunculus decisus Conrad, 1833, Fossil Shells of the Tertiary, p. 39.

Limopsis decisus Conrad, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. iv, p. 297, pl. xlvii, fig. 13.

(?) *Noetia pulchra* Gabb, 1860, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. iv, p. 388, pl. lxvii, fig. 65.

Trigonoarca pulchra var. Harris, 1897, Bull. Amer. Pal. No. 9, p. 48, pl. viii, figs. 2, 2*a*.

Description.—" Shell longitudinally suboval, equilateral, with obsolete radiating striae; posterior end obliquely truncated, umbonial slope angulated, incurved; beaks small, pointed and recurved; cardinal teeth small and crowded; series not much arcuated; margin entire. Length, ½ of an inch." Conrad, 1833.

This form is smaller and proportionally longer than *T. pulchra* Gabb

and has fainter sculpture. It is much more like the variety figured by Harris.

Length, 4 mm.; width, 2.5 mm.

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Maryland Geological Survey.

Family PARALLELODONTIDAE.

Genus CUCULLAEA Lamarck.

Cucullaea gigantea Conrad.

Plates LII, LIII, LIV, LV.

Cucullaea gigantea Conrad, 1830, Jour. Acad. Nat. Sci. Phila., vol. vi, p. 227, pl. x, fig. 4.

Cucullaea onochela Rogers, 1839, Trans. Amer. Philos. Soc., vol. vi, p. 372, pl. xxviii, fig. 2.

Cucullaea transversa Rogers, 1839, Trans. Amer. Philos. Soc., vol. vi, p. 373, pl. xxix, fig. 1.

Cucullaea gigantea H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 98.

Cucullaea onochela H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 98.

Cucullaea transversa H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 98.

Cucullaea rogersiana Nyst, 1848, Tabl. Synopt. Arcacées, p. 63.

Latiarca gigantea Conrad, 1865, Amer. Jour. Conch., vol. i, p. 11.

Latiarca onochela Conrad, 1865, Amer. Jour. Conch., vol. 1, p. 11.

Latiarca transversa Conrad, 1865, Amer. Jour. Conch., vol. i, p. 11.

Latiarca gigantea Conrad, 1866, Smith. Misc. Coll. (200), p. 4.

Latiarca onochela Conrad, 1866, Smith. Misc. Coll. (200), p. 4.

Latiarca transversa Conrad, 1866, Smith. Misc. Coll. (200), p. 4.

Latiarca idonea Conrad, 1872, Proc. Acad. Nat. Sci. Phila., p. 53, pl. ii, fig. 1.

Arca rogersi Heilprin, 1881, Proc. Acad. Nat. Sci. Phila., p. 449.

Cucullaea onochela Rogers, 1884, Geology of the Virginias, p. 669, pl. iii, fig. 2.

Cucullaea transversa Rogers, 1884, Geology of the Virginias, p. 670, pl. iv, fig. 1.

Arca onochela Heilprin, 1884, Contrib. Tert. Geol. and Pal., p. 87.

Cucullaea transversa Harris, 1894, Amer. Jour. Sci., ser. iii, vol. xlvii, p. 302.

Cucullaea gigantea Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Cucullaea gigantea Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 84, pl. xxx, xxxi, xxxii, xxxiii.

Cucullaea gigantea var. Harris, 1897, Bull. Amer. Pal. No. 9, p. 49, pl. viii, figs. 3*a*, 4.

Cucullaea gigantea Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, p. 603.

Cucullaea transversa Dall, 1898, Trans. Wagner Free Inst. Sci., vol. iii, pt. iv, pp. 603, 646.

Description.—" Shell subtriangular, obliquely cordate; very ventricose, with numerous longitudinal sulci; anterior side flattened, produced

and subcuneiform; posterior side very short; umbones gibbous; beaks distant and much incurved." Conrad, 1830.

A careful examination of the various forms of *Cucullaea* from the Maryland and Virginia Eocene shows them to be modifications of a single species that possesses great variability in outline and surface decoration. The most profound changes appear upon comparison of young and adult forms. The immature shells are relatively not as high or as tumid and possess much narrower ligament areas than the adults. Rogers gave the name of *C. transversa* to these young forms. Casts of the larger shells are not uncommon and are locally known as "turtle heads."

Professor Harris agrees with us in regarding the Maryland-Virginia Cucullaeas as all of one species, and also includes in it a form from the Chickasawan of Alabama of the *transversa* type. Dr. Dall, however, recognizes two species. If it were possible to separate the forms the distinction between the *gigantea* and *transversa* types would be very useful, since the former occurs only in the Aquia formation, while the latter is the only form found in the Nanjemoy formation or in the Gulf states.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock, Thrift (well). Aquia Formation. Liverpool Point, 1 mile southeast of Mason Springs, Potomac Creek, Paspotansa Creek, 2 miles below Potomac Creek, Aquia Creek, Clifton Beach, 1 mile northeast of Piscataway, Upper Marlboro, Hardesty, Rolph's Landing, 3 miles west of Leeland, Fort Washington, Glymont, Sheckel's Farm near South River, Fredericktown (?).

Collections.—Maryland Geological Survey, Johns Hopkins University, U. S. National Museum, Philadelphia Academy of Natural Sciences.

Leda parva (Rogers).

Plate LVI, Figs. 5, 6, 7, 7a.

Nucula parva Rogers, 1837, Trans. Amer. Philos. Soc., vol. v, p. 340. (Reprint Geology of the Virginias, 1884, p. 668.)

Nucula parva H. C. Lea, 1848, Proc. Acad. Nat. Sci., Phila., vol. iv, p. 102.

Leda parva Conrad, 1854, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 29.

Nuculana parva Conrad, 1865, Amer. Jour. Conch., vol. i, p. 3.

Nuculana parva Conrad, 1866, Smith. Misc. Coll. (200), p. 3.

Leda parva Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Leda parva Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 83, pl. xxviii, figs. 2*a*–2*d*

Description.—"Shell ovate, inflated, rounded before, not much produced, but rapidly tapering to a truncated point behind, furnished with about twelve rather coarse concentric folds or ridges, and a longitudinal gently depressed groove or undulation of surface, running from near the beak to the posterior basal margin; beaks nearly central; anterior series of teeth slightly arched; posterior series nearly straight; margin entire; cavity rather deep." Rogers, 1837.

Length, 5 mm.; height, 3 mm.

Occurrence.—Nanjemoy Formation. Popes Creek, Woodstock, 2½ miles above Popes Creek.

Collections.—Philadelphia Academy of Natural Sciences, Johns Hopkins University, Maryland Geological Survey.

Leda cultelliformis (Rogers).

Plate LVI, Figs. 8, 8a.

Nucula cultelliformis Rogers, 1837, Trans. Amer. Philos. Soc., new series, vol. v, p. 339.

Nucula cultelliformis H. C. Lea, 1848, Proc. Acad. Nat. Sci. Phila., vol. iv, p. 102.

Leda cultelliformis Conrad, 1854, Proc. Acad. Nat. Sci. Phila., vol. vii, p. 29.

Nuculana cultelliformis Conrad, 1865, Amer. Jour. Conch., vol. i, p. 13.

Nuculana cultelliformis Conrad, 1866, Smith. Misc. Coll. (200), p. 3.

Nucula cultelliformis Rogers, 1884, Geology of the Virginias, p. 667.

Yoldia cultelliformis Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Leda (*Adrana*) *cultelliformis* Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 83, pl. xxviii, figs. 3*a*, 3*b*.

Description.—"Shell ovate, ensiform, somewhat inflated, rounded before, much elongated and tapering behind, the posterior length more than twice the anterior, furnished with very fine, hardly distinct concentric striae, and one distinct and one very obscure rib behind; anterior part with an indistinct fold; shell thin; lunule long and lanceolate; beak small; anterior series of the teeth gently arched; posterior series straight; teeth in both acutely bent, the angles directed toward the beak; margin entire; cavity of shell shallow, with a ridge passing from the beak to the posterior margin." Rogers, 1837.

Length, 10 mm.; height, 4 mm.

Occurrence.—Aquia Formation. Clifton Beach. Nanjemoy For-

MATION. Popes Creek, 2½ miles above Popes Creek, Woodstock, Upper Marlboro (deep cut near Chesapeake Beach R. R. station).

Collections.—Johns Hopkins University, Maryland Geological Survey.

Family LEDIDAE.

Genus LEDA Schumacher.

LEDA IMPROCERA (Conrad).

Plate LVI, Figs. 1, 2, 3, 4.

Nucula improcera Conrad, 1848, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 131, pl. xiv, fig. 23.

Nuculana improcera Conrad, 1865, Amer. Jour. Conch., vol. i, p. 13.

Nuculana improcera Conrad, 1866, Smith. Misc. Coll. (200), p. 3.

Leda improcera Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Leda improcera Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 83, pl. xxviii, figs. 1*a*–1*d* (not 1*e*).

Description.—" Elongate, very inequilateral, convex, polished, and having fine indistinct concentric lines; anterior side produced, bicarinated; the upper margin incurved toward the apex; extremity angulated." Conrad, 1848.

This species shows considerable variation in outline. Conrad's types are of the more elongate form. If the more elevated form is a constant variation it should be separated as a new variety or species.

Length, 8 mm.; height, 4 mm. (typical). Length, 11 mm.; height, 7 mm. (elevated form).

Occurrence.—NANJEMOY FORMATION. Popes Creek, Woodstock, Head of Nanjemoy Creek, 2½ miles above Popes Creek.

Collections.—Johns Hopkins University, Maryland Geological Survey.

LEDA PARILIS (Conrad).

Plate LVII, Figs. 1, 2, 2a.

Nucula parilis Conrad, 1848, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. i, p. 132, pl. xiv, fig. 31.

Nucula parilis Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 93.

Description.—" Ovate, ventricose, with concentric lines; beaks medial; anterior end pointed, angular; posterior end regularly rounded; anterior submargin carinated, hinge margin very oblique, straight from

the apex, except near the end where it is somewhat angulated." Conrad, 1848.

This very distinct species has been found only in and immediately above the indurated ledge at Upper Marlboro and South River bridge. It is rare in the indurated ledge but abundant in the shell bed immediately above it. The type which came from Upper Marlboro is still in the collection of the Philadelphia Academy of Natural Sciences.

Length, 15 mm.; height, 9 mm.

Occurrence.—Aquia Formation. Upper Marlboro, Sheckel's Farm near South River.

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences.

Leda parilis var.

Plate LVII, Fig. 3.

Leda improcera Clark, Bull. 141, U. S. Geol. Survey, pl. xxviii, fig. 1*e*.

This form is a connecting link between *L. cliftonensis* and *L. parilis* and might be the descendant of either. It is less globose and has smaller, more numerous folds than *L. parilis;* and is somewhat more elevated than *L. cliftonensis* with smaller, more closely-set folds.

Length, 11 mm.; width, 6.5 mm.

Occurrence.—Nanjemoy Formation. Hills Bridge, Woodstock.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Leda potomacensis n. sp.

Plate LVI, Figs. 9, 10.

(?) *Nuculana protexta* Conrad, 1865, Amer. Jour. Conch., vol. i, p. 147, pl. xi, fig. 6. (In part.)

Leda protexta Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.

Leda protexta Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 82.

Description.—"Shell large, transverse, elongate, anterior side rounded, posterior somewhat longer, attenuated, terminating in an obtuse beak; surface with numerous concentric striations somewhat interfered with on the rostrated portion of the posterior side, where the riblets become more lamellated and wavy and at times even disappear." Clark, 1896.

Nuculana protexta Conrad (1865), which is *Leda protexta* Harris (1897), includes two forms. The first has been described by Dr. Dall as *Leda pharcida* and occurs at Wood's Bluff, Choctaw Corner, and Cave Branch, Ala. The second, which is *Leda protexta* Clark (1896), is described here, and occurs outside of Maryland at Bell's Landing, Gregg's Landing, and Yellow Bluff, Ala. The above localities are all given from material in the collection of the Philadelphia Academy of Natural Sciences.

Length, 37 mm.; width, 17 mm.

Occurrence.—Nanjemoy Formation. Woodstock, West of Port Tobacco, 1 mile southeast of Piscataway, ½ mile below Chapel Point, Charles Branch between Rosaryville and Upper Marlboro, Popes Creek.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Leda cliftonensis n. sp.

Plate LVI, Fig. 11.

Description.—Shell short, ventricose, posteriorly acute, anterior regularly rounded. Surface marked with very regular, concentric folds, with narrow, sharply incised interspaces.

Length, 11 mm.; height, 5 mm.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek, Potomac Creek, Aquia Creek, Liverpool Point, Clifton Beach.

Collection.—Maryland Geological Survey.

Leda tysoni n. sp.

Plate LVII, Figs. 4, 4a, 5.

Description.—Shell of moderate size, thin, not extremely inequilateral; beaks large, proximate; anterior end produced, uniformly rounded; posterior end broad, uniformly rounded; surface marked by fine, regular closely-set rounded lamellae with narrow interspaces; hinge-line nearly straight with from twelve to fifteen teeth on either side of a subumbonal chondrophore.

This species has some resemblance to the figures of *Nucula capsiopsis* de Gregorio.[1]

[1] Ann. Géol. et Pal., vol. ii, p. 187, pl. xxii, figs. 23, 24.

Length, 12 mm.; height, 6.5 mm.

Occurrence.—NANJEMOY FORMATION. Popes Creek, Woodstock, 1 mile southeast of Piscataway, 2¼ to 3 miles above Popes Creek.

Collections.—Maryland Geological Survey, Philadelphia Academy of Natural Sciences.

Family NUCULIDAE.

Genus NUCULA Lamarck.

NUCULA OVULA Lea.

Plate LVII, Fig. 6.

Nucula ovula Lea, 1833, Contrib. to Geol., p. 80, pl. iii, fig. 59.

Description.—"Shell ovate, oblique, inflated, very inequilateral, transversely striate, longitudinally and very minutely ribbed; substance of the shell thin; lunule large, not deeply impressed; beaks pointed, recurved; anterior series of teeth short, posterior series long; fosset nearly direct; cavity of the shell deep; margin very minutely crenulate; nacre pearly." Lea, 1833.

Length, 11 mm.; height, 7.5 mm.

Occurrence.—AQUIA FORMATION. Upper Marlboro, Sheckel's Farm near South River.

Collection.—Maryland Geological Survey.

NUCULA POTOMACENSIS n. sp.

Plate LVII, Figs. 7, 7a, 8, 8a.

Nucula magnifica Clark, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Nucula magnifica Clark, 1896, Bull. 141, U. S. Geol. Survey, p. 82.
Not *Nucula magnifica* Conrad.

Description.—Shell small, thin, fragile; valves shallow; surface marked by strong radial striae which are stronger toward the periphery, and along which the shell tends to fracture; margin strongly crenulated; lines of growth faint and irregular, other concentric sculpture lacking; interior with a silvery luster; beaks anteriorly situated; lunule indistinct; chondrophore narrow, oblique; anterior teeth about fifteen, posterior teeth about six.

Length, 11 mm.; height, 8 mm.

Occurrence.—NANJEMOY FORMATION. Woodstock, Head of Nanjemoy Creek, Charles Branch between Rosaryville and Upper Marlboro, Popes Creek, East and west of Port Tobacco, Upper Marlboro (deep cut near Chesapeake Beach R. R. station), 2½ miles above Popes Creek.

Collections.—Maryland Geological Survey, Johns Hopkins University.

MOLLUSCOIDEA.

CLASS BRACHIOPODA.

Order TELEOTREMATA.

Family TEREBRATELLIDAE.

Genus PLATIDIA Costa.

PLATIDIA MARYLANDICA n. sp.

Plate LVIII, Figs. 1, 1a, 1b, 1c.

Description.—Shell small, subcircular, somewhat depressed, with well-marked lines of growth; ventral valve with hinge-area prominent, high, bisected by a large open foramen and with a well-defined, linear septum in the interior; dorsal valve with large pedicle incision, and with a short, high, slightly bifurcated medium septum in the interior; teeth and sockets prominent; shell structure minutely punctate.

This beautiful little brachiopod is not uncommon at Upper Marlboro where it is found associated with bryozoans and foraminifera. There is no other American fossil species of this genus.

Length, 4 mm.; width. 4 mm.

Occurrence.—AQUIA FORMATION. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family TEREBRATULIDAE.

Genus TEREBRATULA Llhwyd.

TEREBRATULA HARLANI Morton.

Plate LVIII, Figs. 2, 3, 3a.

Terebratula harlani Morton, 1829, Jour. Acad. Nat. Sci. Phila., vol. vi, p. 73, pl. iii, figs. 1–4, 7, 8; Amer. Jour. Sci., vol. xvii, p. 283; vol. xviii, pl. iii, fig. 16.

Terebratula harlani Bagg, 1898, Amer. Geol., vol. xxii, p. 370.

Description.—"Shell large, about twice as long as broad, sides straight and imperfectly parallel; upper valve plano-convex, obscurely biplicated except near the margin, which has three inconsiderable sinuses; lower valve very convex, with a longitudinal ridge and slight lateral depressions; beak incurved; umbo prominent." Morton, 1829.

Mr. Schuchert states in a private communication that "The *Terebratula harlani* from the Eocene show a tendency to variation which if constant I would use as a distinguishing character for the establishing of a variety. This tendency is for the shell to become a little wider with the loss of lobation. Similar shells also occur among the Cretaceous specimens but the form seems to be rare. If in the Eocene this form is the prevailing one then it shows the line of variation in evolution. However, if you give these Eocene specimens a varietal name, call attention to the fact that the identification cannot be made from single specimens.

"Another slight difference is the wide area on each side of the crural processes. This also has no particular value. I should never have believed the finding of *Terebratula harlani* in Eocene strata had I not seen these specimens with your remarks as to occurrence and associated Eocene fossils."

Whether the specimens of *Terebratula harlani* found associated with typical Eocene fossils are to be regarded as mechanically derived from Cretaceous deposits or are really Eocene representatives of this important species the authors have not been able to determine. A careful study of the many shells found does not afford any evidence that they were transported to any distance although in some instances occurring well above the base of the Eocene. Furthermore, it cannot be definitely

shown, so far as these occurrences are concerned, that the Rancocas formation, to which *Terebratula harlani* is limited farther north, really exists or ever did exist in the area below the Eocene strata. The specimens obtained, however, are not unlike the Cretaceous forms. It is important in this connection that they have never been observed in the intervening Manasquan and Shark River formations, both of which have furnished a considerable number of other species.

The specimens vary considerably in size, although the larger forms predominate. The largest specimens are from 70 to 80 mm. in height and 40 to 50 mm. in width.

Occurrence.—Aquia Formation. 3 miles west of Leeland, Severn River opposite Annapolis.

Collections.—Maryland Geological Survey, Maryland Academy of Sciences.

Class BRYOZOA.

Order CYCLOSTOMATA.

Family TUBULIPORIDAE.

Genus DISCOSPARSA d'Orbigny.

Discosparsa varians n. sp.

Plate LIX, Fig. 3.

Description.—Zoarium forming subcircular (young) or irregular, undulating expansions, 2 to 10 mm. wide, parasitically attached, or more or less free and epithecated beneath. In young colonies which are often spread over the original layer, the zooecial apertures, which are enclosed by moderately elevated, ring-like peristomes, are, sometimes uniserially, but never very regularly, arranged in a radiate manner about the small, depressed and smooth central space. In older examples, there are several of these maculae, but the radial arrangement of the zooecia about them, is generally obscure. The ooecia immediately surrounding the maculae are often of larger size and more oblique than those covering the intermediate spaces where they are quite direct, but in worn examples very little difference in size is noticeable. The interzooecial

spaces, which are solid and concave normally, are pitted in worn specimens as though they contained covered mesopores or vesicles. The unworn covering is minutely punctate, as are also the covers closing some of the zooecial apertures. The zooecia form mere inflations of the surface, usually (perhaps always) over one of the maculae, which in that case is slightly raised instead of depressed and pierced by somewhat scattered apertures. An average of nine zooecia occur in 2 mm. Tube walls as seen in fractured specimens, thin beneath the outer crust, minutely perforated, the pores arranged in transverse series with nearly three of the rows in the space equalling the width of a tube. No diaphragms were observed. Length of tubes, 1 mm. or less.

The Lower Eocene specimens have been identified with a common form in the washings of the Upper Cretaceous at Vincentown, N. J. In the latter the arrangement of the zooecia is usually more regular and the maculae scarcely so noticeable as they are in the Upper Marlboro specimens, but other Vincentown specimens agree very closely with the one illustrated on Plate LIX, Fig. 3. The generic position of the species may be considered a trifle doubtful. The wholly parasitic specimens would probably be placed by most authors under *Berenicea,* but it does not seem that the species in any of its forms is ever truly a *Berenicea.* Besides, these parasitic specimens cannot possibly be distinguished in other respects from the free laminar and even discoid specimens here united with them. *Discosparsa* as established by d'Orbigny and accepted by Pergens, includes discoid or cupuliform zoaria, attached by the central portion of the base only. The zooecial apertures are disposed irregularly or in intersecting curved lines about the center of the upper surface. As these conditions are fully complied with by at least some of the Vincentown specimens of *D. varians,* it appears reasonable to place the species under *Discosparsa* rather than *Berenicea.* There is no described American species closely resembling *D. varians* and none of those from European deposits seem near enough to require detailed comparison. The species is common in the Upper Cretaceous at Vincentown, N. J.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family FASCIPORIDAE.

Genus FASCIPORA d'Orbigny.

Fascipora subramosa n. sp.

Plate LIX, Figs. 1, 2.

Description.—Zoarium consisting of small flattened branches, varying from subcylindrical to flabellate, usually about 1.5 mm. in thickness. Ends of branches convex, occupied by the mouths of numerous subequal, thin-walled, angular tubes, usually about 0.12 mm. in diameter. Sides of branches with rather obscure transverse wrinkles and the apertures of the true or fully-developed zooecia. The latter are somewhat scattered, though a tendency to arrangement in series—chiefly longitudinal—is commonly apparent. The rounded contour of the zooecial tube-wall is but dimly discernible behind the moderately raised apertural rims. Zooecial apertures ovate, about 0.14 mm. by 0.18 mm., with about five in 2 mm. Interapertural space as well as apertural covers, minutely punctate. In vertical fractures the tubes are shown to be very long and that they approach the surface very gradually. Ooecium a mere inflation of the surface through which one or more of the zooecial tubes pass.

In the general form of its zoarium this species agrees very well with *F. pavonina* (Michelin) d'Orbigny's type of the genus, but its zooecia are much smaller and not nearly so prominent.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family IDMONIIDAE.

Genus RETICULIPORA d'Orbigny.

Reticulipora dichotoma Gabb and Horn.

Plate LIX, Figs. 9-12.

Reticulipora dichotoma Gabb and Horn, 1862, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. v, p. 173, pl. xxi, fig. 64.

Comp. *Bicrisina gandryana* Pergens, 1890, Revis. des Bryozoaires du Crétacé, Bull. Soc. Belge de Géol., t. iii, pl. xiii, fig. 2.

Description.—Fragments only of this species have been seen. So far as these admit of judging, the zoarium is not reticulated but consists of

laterally compressed curved branches, 2 to 3 mm. wide or high and 1 mm. or less thick, throwing off similar branches from their sides. Occasionally they appear to divide dichotomously, but this probably is not really the case. The zooecial apertures are subcircular or oval, 0.08 to 0.10 mm. in diameter, arranged in more or less irregular transverse series, five or six in 1 mm., oblique, with the peristome higher behind than in front. Except for an occasional large cell (? zooecium) the lower third or half of the branches is without zooecial apertures and in the worn condition may appear quite solid. When in a good state of preservation, however, this part of the surface is covered by angular depressions, of varying sizes, the centers of the depressions usually showing the mouth of a small pore. Similar pores extend upward and occupy the depressed spaces between the rows of zooecial apertures. Gonocysts of the same type as in *Berenicea*, *Discosparsa* and *Fascipora*. The zooecial tubes pass through them without interruption, but the mesopores do not. Closures of zooecial tubes, some distance below the external orifice, appear to have a central perforation.

A species recently described by Pergens (*loc. cit*) from the Cretaceous (Senonien) of France, under the name of *Bicrisina gaudryana*, is either the same as *R. dichotoma* or extremely like it. The species occurs in the Upper Cretaceous at Timber Creek and Vincentown, N. J.

Occurrence. Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family CERIOPORIDAE.

Genus CAVARIA Hagenow.

Cavaria dumosa n. sp.

Plate LIX, Figs. 4-8.

Description.—Zoarium forming small, bushy masses, consisting of frequently and irregularly dividing and coalescing branches, varying in thickness generally from 1.5 to 2.0 mm., but occasionally reaching 3.0 mm. Surface of the most nearly perfect specimens exhibiting at irregular intervals; small, slightly depressed maculae, smooth or occupied solely by mesopores. In these specimens the zooecia are readily distinguished from the mesopores by their prominent peristomes and

rounded as well as larger apertures. The mesopores occur in the maculae and in the depressed spaces between the zooecia, are something like twice as numerous as the latter, and have small though variable apertures set in the bottoms of rounded or angular depressions. Inner diameter of zooecial apertures about 0.8 mm., with four in the space of 1.0 mm. In young or slightly worn examples the maculae are not readily distinguished, the mesopores relatively larger and the two sets of mouths more nearly alike than in the condition described above. Gonocysts large, appearing as rounded or irregular inflations of the surface perforated by the mouths of zooecial tubes which pass through them without interruption. Beside each zooecium is the orifice of a smaller tube, the nature of which is not understood. When the outer wall of the gonocyst is broken away, the zooecial tubes, together with the small tubes accompanying them, are turned in every direction away from the center. Between them the mouths of the mesopores are covered by a perforated pellicle.

The axial hollow or tube varies between 0.2 and 0.4 mm. in diameter, is wrinkled transversely and further constricted at irregular intervals. At the constrictions a thin curved plate is often observable, but that it extends completely across the cavity has not been observed and from the evidence at hand it is at least doubtful that it ever does. The tubes, as seen in fractures, present no evidence of diaphragms, but the connecting perforations in the walls are quite distinct. They occur mostly in transverse rows, two or three of the rows in a space equalling the width of a tube.

Superficially there is considerable resemblance between this species and *Heteropora* (*Multicrescis*) *parvicella* Gabb and Horn, a common fossil of the Upper Cretaceous deposits at Vincentown, N. J. The ramulets of that species, however, are more slender and divide less frequently while its zooecia and mesopores appear more scattered. But the principal difference lies in the central hollow which is wanting in Gabb and Horn's species and distinguishes *Cavaria* from *Heteropora*. Of the three species of *Cavaria* described by Hagenow, only *C. ramosa*, the type of the genus, is at all similar. In this the axial hollow is relatively larger and is crossed by strong transverse partitions. The branches

also appear to be smaller and the apertures of both zooecia and mesopores smaller, more angular and less regularly disposed than in *C. ramosa.*

Occurrence.—Aquia Formation. Upper Marlboro (in fragments).

Collection.—Maryland Geological Survey.

Genus CERIOPORA Goldfuss.

Ceriopora micropora Goldfuss.

Plate LIX, Figs. 13, 14.

Ceriopora micropora Goldfuss, 1822, Petr. i, p. 33, pl. x, fig. 4*d* (not 4*a–c*).

Ceriopora micropora Hagenow, 1851, Die Bryozoen der Maastrichter Kreide bildung, p. 52, pl. v, fig. 4.

Description.—Among the Survey material received for description is a single zoarium agreeing too closely with *C. micropora,* as redefined by Hagenow and represented by several examples in the author's private collection received from Dr. Ed. Pergens, to admit of distinguishing it at present. The specimen is depressed globular in shape, nearly 5 mm. in diameter, hollow beneath, and composed of at least three layers of zooecia. The zooecial apertures are not very clearly shown by the specimen but appear to be a trifle smaller, more unequal and thinner walled than in the Maastricht colonies.

Occurrence. Nanjemoy Formation. $2\frac{1}{2}$ miles above Popes Creek.

Collection.—Maryland Geological Survey.

Genus HETEROPORA Blainville.

Heteropora (?) tecta n. sp.

Plate LIX, Figs. 15, 16.

Description.—Zoarium consisting of small, subramose masses or stems, 2 or 3 mm. in thickness, the upper ends of which are rounded and covered uniformly with angular thin-walled tube mouths, about seven in 1 mm. A large proportion of the sides of the specimen figured is covered with a thin and minutely punctate pellicle, the tube apertures covered thereby being quite obscured. Most of the apertures showing through or piercing the pellicle, are of rounded form, with an inside diameter of about 0.13 mm., and enclosed by a ring-like peristome.

These are regarded as the true zooecia, the other tubes being probably all of the nature of mesopores. In longitudinal sections the tubes have thin walls, perforated as usual, are developed in any part of the axial region and approach the surface in a very gradual curve. No diaphragms were observed.

No *Heteropora* has been seen by the author that resembles this species very closely. Indeed, there is a doubt regarding its belonging to this genus, but, after comparing it with all the described genera of this section of the Cyclostomata, it appears to agree better with *Heteropora* than with any of the other genera.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Order CHILOSTOMATA.

Family MEMBRANIPORIDAE.

Genus MEMBRANIPORA Blainville.

Membranipora rimulata n. sp.

Plate LX, Figs. 1, 2.

Description.—Zoarium adnate, forming a thin, single sheet of indefinite extent. Zooecia hexagonal in form, arranged quincuncially with the longitudinal rows generally very regular. Apertures occupying the whole of the large opesium, quite regularly ovate in shape. Rim or interapertural space narrower than the opesia, rounded, sometimes angular in the middle but oftener with a depressed interzooecial suture line, marked with close transverse lines or wrinkles. Taking the place of an ordinary zooecium isolated cells or, more commonly, two or three in longitudinal sequence; occur which differ from the rest in having a convex cover with a narrow median slit and above the slit a linear crescentic impression. These cells may represent an unusual type of ooecia but more probably are to be considered as a form of vicarious avicularia or vibracula.

The specimens upon which the species is founded are divisible into two varieties, one with smaller zooecia and opesia and thicker walls

than the other. Measuring longitudinally the former has four and one-half zooecia in 2 mm., the other only three and a half. Diagonally one has six, the other five in the same space. Thickness of zooarial sheet not exceeding 0.2 mm.

Membranipora perampla Gabb and Horn, which occurs rather frequently in the Upper Cretaceous at Vincentown and other points in New Jersey, sometimes resembles this species, but its zooecia are larger, less regular, with irregular spaces often between the rims and one side of the latter generally higher than the other, while none of the covered cells described above have so far been observed in it. The zooecia are more regularly arranged in *M. rimulata* than in any of the simple species of the genus known to the writer, and this fact, together with the presence of the peculiar covered cells, is principally relied upon in distinguishing the species. Two fragments in my collection of Cretaceous bryozoa found at Vincentown, N. J., and regarded as *Biflustra disjuncta* Gabb and Horn, have very similar covered cells, and, considering the variations shown in my specimens of this species, seem to show a closer relation to *M. rimulata* than to any other form.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Membranipora spiculosa n. sp.

Plate LX, Figs. 3, 4.

Description.—Zoarium adnate. Zooecia arranged in quincunx or irregularly, oblong, rounded and widest above, more or less produced below. Opesia large, normally ovate, the upper edge nicely rounded, the lower variable, taking up about half of the length of the zooecium. Rim thin, highest above, usually dying out before reaching lower extremity of zooecium. Front wall over lower half of zooecium, slightly depressed, covered with small granules or spines, those bordering the edge projecting sharply into the opesial opening. Ooecia numerous, cucullate, strongly elevated, often with a tubercle or point forming the summit. When a zooecium is without an ooecium its place is often occupied by an elevated avicularium of moderate size. The avicularia are very few in number but when present similar to those found in *Repto-*

flustrella heteropora Gabb and Horn. Length of zooecium 0.5 or 0.6 mm.; width 0.25 to 0.30 mm. The specimen described shows a single cell differing from the rest in being closed, a convex cover, at the upper extremity of which a semi-circular impression is distinguishable, extending over the whole.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Membranipora angusta n. sp.

Plate LX, Figs. 5, 6.

Description.—Among the material from Upper Marlboro, there are several specimens of a delicate *Membranipora* that, on account of their imperfection and fragile nature, it may be risky to distinguish as a new species. However, as it is easily recognized and may prove useful in stratigraphic studies the writer has ventured to name it as above. The zooecia are shallow, elongate, elliptical, hexagonal or rhomboidal and separated except in young stages by a thin tuberculated wall common to adjoining cells (i. e. there is usually no depressed dividing line between the zooecia). The inner portion of the wall is much thicker than the outer, so that the mouths of the connecting pores, of which there are at least six on each side and one or two at each end, are clearly shown in a view of the front. Two specimens have cucullate ooecia as shown in Figure 5, and on all an occasional small oval or rounded and slightly raised avicularium may be noticed. The zooecia are about 0.4 mm. long and 0.2 mm. wide. *M. angusta* apparently belongs to the *M. lineata* group of Waters.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Genus REPTOFLUSTRELLA d'Orbigny.

Reptoflustrella heteropora Gabb and Horn.

Plate LX, Figs. 8, 9.

Reptoflustrella heteropora Gabb and Horn, 1862, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. v, p. 162, pl. xx, fig. 50.

Description.—" Colony encrusting in irregular patches. Cellules in a single layer, placed with but little regularity, but with a tendency to

radiating lines; elongate, acuminate anteriorly, broadly truncate behind. Opening subtriangular, with the sides convex, often approaching an oval in very long cellules. Surface regularly convex, bordered anteriorly and laterally by a slightly elevated, rounded edge, usually becoming obsolete as it approaches the proximal end of the cellule. Special pore placed *in advance* of the opening, small and round. No ovarian vesicles were observed. Old cellules are closed over by a continuation of the surface wall totally obliterating the aperture. In this case the 'special pore' is also generally obliterated, merely showing a slight depression." Gabb and Horn, 1862.

The Eocene specimens are coarser in appearance than the Cretaceous form of the species, of which the writer has a number of excellent examples. They differ further in the more pronounced character of the granulation of the front wall and opesial margin, the Cretaceous form being almost smooth; in more frequently assuming a rhomboidal form of zooecium; and in the relatively smaller size of the opesium and larger avicularia. Cucullate ooecia, less prominent but otherwise similar to those of *Membranipora spiculosa,* occur not infrequently upon the Cretaceous specimens but are wanting on the Eocene material in hand. When these occur they take the place of the avicularium which otherwise occurs invariably on, or, just above, the upper rim of the zooecium.

The species occurs in the Cretaceous at Mullica Hill, Timber Creek, and Vincentown, N. J.

Membranipora spiculosa is a closely related species, but has a more ovate and larger opesium and differently shaped zooecia.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Genus BIFLUSTRA d'Orbigny.

Biflustra torta Gabb and Horn.

Plate LX, Fig. 7.

Biflustra torta Gabb and Horn, 1862, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. v, p. 152, pl. xx, fig. 36.

Description.—" Colony composed of very compressed branches, usually twisted, rarely in the same plane for more than a quarter of an

inch. Cellules arranged in longitudinal lines and usually in quincunx. About six to ten rows on each side of the branches, although we have in one case counted twenty just below a bifurcation. Cellules closely juxtaposed; elongated oval anteriorly, contracted and afterwards dilated posteriorly, and straight or slightly emarginate at the proximal edge. Opening elongated oval, variable in form and size, occasionally subquadrate, sometimes slightly narrowed posteriorly, either more or less than half the surface of the cellule, no lip or margin, simply pierced in the substance of the cellular wall and placed at the lowest part of the surface. Surface smooth, concave, elevated at the anterior and antero-lateral margins into a rounded or acute edge, a little higher than the posterior of the surface of the adjoining cellules. From this edge the surface slopes inwards toward the mouth. Behind the mouth the surface is generally marked by two radiating depressed lines, running from the proximal corners of the mouth to the corresponding corners of the cellule, between which is a rounded elevation, not as high, however, as the anterior end of the preceding cellule.

The accessory cells [vicarious avicularia] appear to be ordinary cellules undeveloped, and are not always placed immediately in advance of an ordinary cellule. They are about two-thirds of the ordinary size, not closed above, by a testaceous covering, but have the anterior edge very much produced, thin and overhanging, and about as high as the length of the aperture. We have noticed but one broken ovarian vesicle, which is placed in advance of the cellule to which it belongs, appears to have been semiglobular and overlaps the proximal surface of the succeeding cellule, reaching to the edge of the aperture." Gabb and Horn, 1862.

Although rather variable this is still to be counted as an easily recognized species. Ooecia occur but rarely, only four or five specimens out of fifty or more in my collection having any at all. They are cucullate, often with a delicate longitudinal ridge across them and about as large as in *Membranipora spiculosa*, but more uniformly convex. The species occurs in the Upper Cretaceous at Mullica Hill, Timber Creek, and Vincentown, N. J.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

ESCHARA (??) DIGITATA Morton.[1]

Plate LX, Figs. 10, 11.

Eschara digitata Morton, 1834, Syn. Org. Rem. Cretaceous Group, p. 79, pl. xiii, fig. 8.

Eschara digitata Lonsdale, 1845, Quart. Jour. Geol. Soc. London, vol. i, p. 73, figs. *c*, *d*, *g*, (*a* and *b*?) exclus. *e* and *f*.

Eschara digitata d'Orbigny, 1850, Prod. Pal. Strat., vol. ii, p. 264.

Eschara digitata Gabb and Horn, 1862, Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. v, p. 114.

Description.—Zoarium bifoliate, branching dichotomously; branches flattened, acutely elliptical in cross-section, usually 2.5 to 3.0 mm. wide. Zooecia hexagonal, regularly arranged in quincunx, about 0.55 mm. long and 0.38 wide, bounded by a slightly impressed line; surface concave, especially toward the aperture which is situated usually just in front of the center. Aperture semielliptical, rounded in front, straight behind, 0.10 to 0.12 mm. wide. Normally developed and perfect, the posterior border of the aperture is slightly raised and bears a delicate lunarium-like curved plate which extends into the aperture. Abortive cells, possibly of the nature of vicarious avicularia, are frequent but seem to be entirely restricted to the edges of the zoarium and to those portions lying just beneath the axes of bifurcation. They are distinguished from the other cells by their subcircular and usually much smaller apertures. Ooecia unknown. The species occurs abundantly in the Upper Cretaceous at Mullica Hill, Timber Creek, and Vincentown, N. J.

Occurrence.—AQUIA FORMATION. Upper Marlboro (rare).

Collection.—Maryland Geological Survey.

[1] Of course this species does not belong to the genus *Eschara* as now understood. Like *Biflustra torta* it belongs near or to the genus *Onychocella* Jullian, which is variously regarded, by some as a mere section of *Membranipora*, by others as a distinct genus or even as the type of a new family, while Gregory makes it a member of the *Microporidae*. At present I regard *Onychocella*, taking such a form as *Membranipora angulosa* Reuss, as a typical species, as clearly entitled to generic rank and as probably representing a distinct family. It would, however, to say the least, be premature to place either *Biflustra torta* or *Eschara digitata* under *Onychocella*, since neither accords strictly with the more typical species of the proposed genus. When raised to the rank of a family it is highly probable that other generic groups will be established into which these species would fall more naturally than into *Onychocella* proper. Careful Mr. Waters has already instituted a second genus of the *Onychocella* type—*Vibracella*—for *Flustrellaria trapezoidea* Reuss, while it may yet become desirable to employ some of the names proposed by d'Orbigny for related types. Under these circumstances I prefer leaving the species where Gabb and Horn placed them.

Genus LUNULITES Lamarck.

LUNULITES REVERSA n. sp.

Plate LX, Figs. 19, 20.

Description.—Zoarium flabellate (perhaps originally discoid or depressed conical), zooecia subquadrate or pentagonal, usually widest in the anterior half, arranged in rather irregular radiating lines, about six in 2 mm., with an impressed line separating the rows; area depressed, its surface grano-lineate. Margin strongly raised, thick, and straight or slightly concave across the posterior end and much thinner along the sides, the anterior end appearing to be overlapped by the posterior ridge of the next succeeding zooecium. Aperture surrounded by a thickened rim, generally rounded in front and straighter behind, sometimes subquadrate, its anterior border close to the prominent end of the next cell, and the length and width averaging about half the corresponding dimensions of the entire zooecium.

Vibracular cells fusiform or elongate oval, rather large, one, usually at each angle of junction between four zooecia. A constriction occurs near the center of each, sometimes on one side only, at other times on both. A narrow area may surround the opening. Under surface marked by irregular depressed lines radiating from the narrow lower extremity of the zoarium. Between these lines the surface is convex and rather coarsely pitted and granulate.

The only specimen seen is too imperfect to permit a positive declaration that it is not a mere fragment of a discoid zoarium. Still, the arrangement of the depressed lines on the lower surface does not look right for a species in which the zooecia radiate from a center as in the ordinary forms of *Lunulites.* On the other hand this side looks decidedly like d'Orbigny's figure of his *Pavolunulites elegans* (Pal. Franc., vol. v, pl. dccvi, fig. 7), hence I expect to find that perfect specimens of *L. reversa* have a flabellate and not a discoid or conical form.

Specifically, *L. reversa* is distinguished from all species of Lunulites known to the writer, except *L. regularis* d'Orbigny, *L. semilunaris* Marsson and *L. patelliformis* Marsson, in having the posterior margin of the zooecium thicker and more premoinent than the anterior. From the species mentioned it differs in the greater elevation and square out-

line of the raised margin, in the larger size and different form of the aperture, and the grano-lineate marking of the whole surface.

Occurrence.—Aquia Formation. 2 miles below Potomac Creek.

Collection.—Maryland Geological Survey.

Family CRIBRILINIDAE.

Genus CRIBRILINA Hincks.

Cribrilina modesta n. sp.

Plate LX, Figs. 12, 13.

Description.—Zoarium forming a delicate parasitic patch upon foreign bodies. Zooecia ovate, not very regularly arranged, about 0.4 mm. in length and 0.28 mm. wide, bordered by a thin rim. Front wall gently convex, usually with six (five to seven) radiating and transverse furrows, each with two or three pores, on each side, and a central, flattened, ovate or triangular space, including five or six similar pores placed in obscure transverse furrows. Apertures rounded, prominent, oblique, the posterior edge highest and often thickened in its central portion. Small avicularian cells occur near or attached to one part or another of the apertural rim of most zooecia, generally one to each, rarely two. Where three zooecia join there is usually a small open space (? vibracular cell). Ooecia cucullate, moderately arched.

I could find none among the numerous species of *Cribrilina* and the related, if not congeneric, forms referred to *Escharipora, Semiescharipora* and *Reptescharipora* by d'Orbigny that exactly matches the fossil above described. It is distinguished from nearly all of them by the cribrose, central space on the front wall, and the prominent rounded aperture.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Cribrilina crassula n. sp.

Plate LX, Fig. 14.

Description.—Zoarium encrusting. Zooecia oblong quadrate or hexagonal, irregularly arranged, with a heavy, strongly elevated margin,

clithridate in outline. Front wall with a narrow raised ridge running down its center, and five or six transverse and radiating rows of minute punctures lying in furrows. Apertures rounded or subovate, the outline often less curved on the posterior side than elsewhere. Avicularian cells small, raised, variously distributed, sometimes one or two and even three to a zooecium; or a cell may have none at all. Ooecia unknown. Zooecia 0.5 to 0.6 mm. in length, 0.25 to 0.30 mm. wide; about seven in 4 mm. measuring lengthwise.

The thick marginal rim of the zooecia and the unusual depression of the front wall are regarded as the distinctive characters. The latter feature seems to occur also in *Escharipora immersa* Gabb and Horn, a species described but unfortunately not figured in their monograph, and founded on a specimen from the Cretaceous at Timber Creek, N. J. Their description leaves much in doubt, but as it is stated that the zoarium forms broad, tortuous and anastomosing plates, celluliferous on both faces, and that the zooecia are arranged in regular quincunx, it seems highly improbable that *C. crassula* can be the same species. Of other *Cribrilinidae* known to the writer only *Escharipora incrassata* d'Orbigny, from the Cretaceous of France, presents considerable resemblance. That species, however, grows into bifoliate expansions, has larger and relatively longer zooecia and large accessory cells (? vicarious avicularia) not observed in *C. crassula.*

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Family ESCHARIDAE.

Genus LEPRALIA Johnston.

Lepralia subplana n. sp.

Plate LIX, Figs. 17, 18.

Description.—Zoarium, as seen in three specimens, forming a hollow cylinder, composed of numerous layers, each 0.3 to 0.35 mm. in thickness, and varying in diameter according to the number of layers from 7.0 to 13.0 mm. Zoöecia not very regularly arranged, sometimes subovate, at other times hexagonal or subquadrate, longer than wide, the length averaging about 0.45 mm. Upper surface nearly flat, the outline

of the zooecia, in aged conditions especially, scarcely distinguishable and mainly by a double row of pores which, as shown by fractures, are the mouths of small tubes traversing the walls in a vertical direction. Front wall slightly convex, perforated, the pores usually smaller than those outlining the zooecia, distinctly visible on the inner surface, sometimes wanting over a varying space just behind the aperture. The latter is rounded in front, nearly straight behind, with the angles rounded, generally semielliptical, the width and length averaging, respectively, 0.15 and 0.13 mm. Small, round or oval avicularia generally present. Their position is variable though usually close to the rim of the aperture. While an occasional zooecium may occur, having no avicularia, as many or more will be found having one on each side of the aperture. Ooecia unknown.

Fractures dividing the zooecia vertically (see Fig. 18) show that the walls (side and front) are traversed by minute, wavy, vertical tubuli and that the zooecial cavities are connected by two series of pores, the larger set near the bottom and a row of smaller pores above the midhight. The openings of the larger set are often irregularly distributed over the concave floors of the zooecia.

A fine specimen from the Cretaceous at Vincentown, N. J., is of a species closely related to *L. subplana* but distinguished by several readily apparent differences. In it the young zooecia are more convex than in *L. subplana*, and the convex portion entirely without perforations. With age, however, the surface becomes distinctly pitted. The vibracula also are more regularly and numerously developed, most zooecia having one on each side of the aperture. The Vincentown specimens may belong to Gabb and Horn's *Reptocelleporaria aspera* but certain discrepancies between it and their description and figure render a positive identification impossible at present.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Lepralia labiosa n. sp.

Plate LX, Figs. 15, 16.

Description.—Zoarium forming thin crusts over shells and other foreign bodies. Zooecia rhomboidal, hexagonal or subovate, arranged more

or less irregularly in curved series, five or six in 2 mm. often separated by a depressed line. Front wall punctate, slightly convex, flat, or depressed, the last when the margin on one or both sides is thickened and elevated. Aperture subquadrate or semielliptical, sometimes contracted near the middle, always enclosed by a more or less strongly thickened rim. Avicularia occur on the raised apertural border, usually one to each zooecium, or two, as shown in the figures on Plate LXI. Ooecia unknown.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Genus MUCRONELLA Hincks.

Mucronella aspera n. sp.

Plate LX, Figs. 17, 18.

Description.—Zoarium incrusting, consisting of one or more layers; surface under a low power of magnification presenting a decidedly rough aspect. Zooecia varying from ovate-hexagonal, to sub-rhomboidal, indistinct externally, arranged more or less irregularly, though the rows are more regular than they may appear at first sight; about six in 2 mm. Apertures rounded or subquadrate, 0.13 mm. in diameter, rendered oblique by the elevation of the more or less strongly swollen posterior margin and the depression of the anterior part. The central portion of the raised lip forms a "mucro" of greater or less thickness and prominence, the same hiding a minute central tooth beneath it, and forming with the rest of the thickened portion of the lip, a more or less obscure resemblance to the figure W. Behind the lip the surface slopes rapidly and in the most nearly perfect example is granulose. In the depressed space in front of the aperture there are, normally, three small raised avicularia (? vibracula) while a few larger avicularia, differing further from the others in being divided into two unequal parts by a cross-bar, are scattered without order among the zooecia. Ooecia are not often seen. When present, they occupy the depressed space in front of the aperture, are cucullate, about as large as the zooecial aperture, and usually bear a furrow running from the summit to the concave edge.

While the appearance presented by the surface of the zoarium is subject to considerable variability, the essential characters are nevertheless very constant. Compared with the numerous described species possessing a mucronate aperture, none seems to be nearer than the form described by Gabb and Horn under the name *Escharifora typica*. However, aside from the obvious zoarial differences between the two species, that one being erect and bifoliate, the surface characters of the zooecia are sufficiently different to obviate all necessity for detailed comparisons. Any one familiar with the fossils can scarcely fail to distinguish them at a glance. The species occurs in the Cretaceous at Vincentown, N. J.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

COELENTERATA.

Class ANTHOZOA.

Order HEXACORALLA.

Family TURBINOLIDAE.

Genus FLABELLUM Lesson.

Flabellum sp.

Plate LXI, Figs. 3, 3a.

Flabellum sp. Vaughan, 1900, Mon. U. S. Geol. Survey, No. 39, p. 66.

Description.—" Corallum compressed cuneiform, attached by a short pedicel, with slightly developed marginal wings above the pedicel. The dimensions of the two largest specimens, whose outer surface is unfortunately so very much corroded that its detail is destroyed, are:

	1	2
	mm.	*mm.*
Greater diameter of calice	14	13
Lesser diameter of calice	9	7
Height of corallum	15	15

" Distinct costae correspond to the larger septa. The number of the septa was not determined with certainty, but is about forty.

" This may be a new species, but has a suggestive resemblance to some

varieties of *F. cuneiforme*, and especially to the older varieties of that species." Vaughan, 1900.

Since the above was published Professor Clark has sent me three more specimens of this same species, but the material is not yet sufficient to determine whether the species is new or only a varietal form of some species of the genus found further south. The best specimen is represented by Plate LXI, Figs. 1, 2. The dimensions of this specimen are: greater diameter of calice, 15.5 mm.; lesser diameter of calice, 8 mm.; height of corallum, 12.5 mm. This specimen is not so elongate as the two specimens whose measurements are given above, but there is sufficient material to show that they represent only a single species. It possesses nineteen large septa that reach the columella; in each of eighteen of the loculi between these large septa are three septa, one longer with a shorter on each side. In one loculus there is a solitary short septum.

Comparison may be made with *Flabellum cuneiforme* var. *pachyphyllum* Gabb and Horn, *Flabellum cuneiforme* var. *wailesi* Conrad, and *Flabellum johnsoni* Vaughan. From the first it differs by its epitheca being not so dense, and the corallum is not so solid, the corallum is more fragile; the second is coarser and larger; *F. johnsoni* is not so compressed, the measurements of its calice are: greater diameter about 14 mm., lesser, about 10 mm. or slightly greater. The specimens from Virginia and Maryland are probably nearest to *F. johnsoni*. Its horizon is the Woods Bluff beds of Alabama.

Occurrence.—NANJEMOY FORMATION. Woodstock (three specimens). AQUIA FORMATION. Aquia Creek (six specimens), 1 mile southeast of Piscataway (two specimens, including the one figured).

Collection.—Maryland Geological Survey.

Family TURBINOLIDAE Milne-Edwards and Haime.

Genus TURBINOLIA Lamarck.

TURBINOLIA ACUTICOSTATA Vaughan.

Plate LXI, Figs. 4, 4a, 4b.

Turbinolia acuticostata Vaughan, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 6.
Turbinolia acuticostata Vaughan, 1896, Bull. No. 141, U. S. Geol. Survey, p. 89.
Turbinolia acuticostata Vaughan, 1900, Mon. U. S. Geol. Survey, No. 39, p. 89, pl. vi, figs. 13–13*b*.

Description.—"Conical in shape, as is usual in the genus. Size small. Costae tall and thin with crenate margins. Beginning with 6, 6 more costae are soon developed, making 12, between which in the intercostal furrows are double rows of perforations. The 12-costal condition exists for about 1.5 mm. from the base, when 12 more costae are introduced. The costae on the basal portion of the corallum are very slightly larger than they are on the upper portion; they are not so prominent on the basal portion as in *Turbinolia pharetra.* In the extreme upper portion 24 rudimentary costae are introduced, making the total number 48, twice as many costae as septa. In the intercostal furrows, after the development of the rudimentary costae, there are only single rows of perforations; during the 24-costal stage there are double rows of alternating perforations in the intercostal furrows. The septa are 24 in number, in three cycles. Those of third cycle fuse, about half-way between the corallum wall and the columella, by their margins to the sides of those of the first cycle. The septal faces are beset with distinct, sharp, small spines. All of the septa except those of the first cycle are thin and weak. Columella weak, terminated by a small hexagonal star. Height, 6.5 mm.; diameter of calice, 3 mm." Vaughan, 1900.

Since the original diagnoses of this species and *T. wautubbeensis*[1] were prepared additional specimens have come to notice, making a revision of the critical remarks on these species necessary. The specimen of *T. acuticostata* from Popes Creek possesses a weak columella, with a stellate upper termination. Additional specimens of *T. wautubbeensis* collected by Mr. Frank Burns at Wautubbee, Mississippi, show that that species possesses costae with crenate margins. The costae of the original type of *T. wautubbeensis* are probably worn. These facts have shown that these two species are so closely related that it seemed that it might be necessary to unite them, however, there are still important differential characters. The costal crenations of *T. acuticostata* are coarser than those of *T. wautubbeensis,* and the incisions between the crenations in the former species are deeper than in the latter. The columella in well-preserved specimens of *T. wautubbeensis* is stouter than in *T. acuticostata,* but there is not sufficient good ma-

[1] Mon. U. S. Geol. Survey, No. 39, p. 88, pl. vi, figs. 11–12.

terial to determine the value of this feature. *T. wautubbeensis* is the more robust species, *T. acuticostata* is more slender. The last mentioned difference is the most striking one. It is extremely probable that *T. wautubbeensis* is a direct descendant from *T. acuticostata*.

T. pharetra Lea also possesses a columella with a hexagonal upper termination. It does not possess rudimentary costae, and the costae have entire edges, but it and the two above discussed species are very closely related and probably should be grouped in a section or subgenus of *Turbinolia*.

Occurrence.—NANJEMOY FORMATION. Popes Creek. AQUIA FORMATION. Potomac Creek.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Family CARYOPHYLLIDAE.

Genus TROCHOCYATHUS Milne-Edwards and Haime.

TROCHOCYATHUS CLARKEANUS Vaughan.

Plate LXI, Figs. 5, 5a, 6, 7, 8.

Paracyathus (?) *clarkeanus* Vaughan, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 6.
Paracyathus (?) *clarkeanus* Vaughan, 1896, Bull. No. 141, U. S. Geol. Survey, p. 89.
Trochocyathus clarkeanus Vaughan, 1900, Mon. U. S. Geol. Survey, No. 39, p. 100, pl. vii, figs. 20–23.

Description.—"Corallum conical, usually slightly curved. Cross-section elliptical. Nearly always showing a distinct area of attachment, which is variable in size. Costae not very prominent; acute; 48 in number, corresponding to all the cycles of the septa; nearly equal in size. In young specimens those corresponding to the last cycle of septa are smaller than those earlier developed. No epitheca was observed and is most probably absent. Septa thin, not exsert, sides granulated; 48 in number, arranged in six systems of four cycles each; those of the first three cycles reach the columella; the fourth cycle fuse by their inner margins to the sides of the third cycle. Calicular fossa shallow. Pali apparently before all of the cycles of the septa except the last, small and thin, and appear to be arranged in two crowns. Rudimentary dissepiments apparently present. Columella fascicular; upper surface papillate." Vaughan, 1900.

The measurements of the two specimens are:

	1	2
	mm.	*mm.*
Greater diameter of calice	7	7.75
Lesser diameter of calice	6	5.5
Height of corallum	12.5	9.75

The specimens on which this species is founded are all imperfect. I could not obtain accurate details concerning the characters of the columella or of the pali, but the species seems to present all the essential characters of *Trochocyathus* and is therefore referred to that genus. There is no other species of coral with which it could be confused; therefore critical notes are unnecessary.

Occurrence.—Aquia Formation. Potomac Creek, Aquia Creek, 1 mile northeast of Piscataway, Marlboro Point.

Collections.—Johns Hopkins University, U. S. National Museum, Maryland Geological Survey.

Genus PARACYATHUS Milne-Edwards and Haime.

Paracyathus marylandicus n. sp.

Plate LXI, Figs. 9, 9a, 9b.

Description.—Corallum low, subcylindrical, attached by a wide and somewhat expanded base. Dimensions: greater diameter of calice, 5.75 mm.; lesser diameter of calice, 5 mm.; height of corallum, 5 mm.; greatest width of base, 6.5 mm.

Outer surface of corallum glossy, apparently epitheca is present. Costae corresponding to all septa, low, alternately larger and smaller in size near the calicular margin, but equal near the base, densely granulated and slightly crested along the summit. Granulations also present between the costae. Upper septal margins very slightly exsert. Septa crowded, thin, in four complete cycles; the six primaries slightly the largest and somewhat more prominent; the secondaries slightly smaller than the primaries; the quaternaries are the smallest and the least prominent. The septal faces, beset with small, low, conical granules. Septal margins entire, sometimes transversely undulate. Pali present before all except the last cycle of septa and arranged with diagrammatic regu-

larity. Those before the septa of the first cycle are small, and stand not very high above the papillae of the columella; those before the members of the second are wide and thin; those before the members of the third cycle are very wide and thin, they extend fully one-half the distance from the outer limit of the columella to the wall. The pali before the septa of the second and third cycles arched upward, their sides are granulated in a measure similar to the sides of the septa, their margins are entire and transversely undulate. The calicular fossa is deep, the bottom is gently concave. The upper surface of the columella consists of numerous papillae.

There are from the Eocene of the Gulf states two species with which this species should be compared. The first is *Paracyathus granulosus* Vaughan from Woods Bluff, Alabama. The septa of the first and second cycles in *P. granulosus* are much stouter and have much more prominent margins than in *P. marylandicus.* The costae of *P. granulosus* are thicker and are more prominent than in *P. marylandicus.* The latter difference will be made clear by comparing the figures of the latter species given here with the original figures[1] of the former. The other is *Paracyathus alternatus* Vaughan, from the Lower Claiborne of Louisiana, Mississippi and Texas. It exhibits many points of difference. Its costae and septa are thicker and very much more prominent. The pali are also different. They are stouter and frequently are bilobed[2]. *P. marylandicus* is strikingly different from any other of our Eocene species of *Paracyathus.*

Occurrence.—AQUIA FORMATION. 1 mile northeast of Piscataway.

Collection.—Maryland Geological Survey.

Genus BALANOPHYLLIA Searles-Wood.

BALANOPHYLLIA DESMOPHYLLUM Milne-Edwards and Haime.

Plate LXI, Figs. 10, 11.

Balanophyllia desmophyllum Milne-Edwards and Haime, 1848, Mon. des Eupsammides, Annales sci. nat., 3d ser., vol. x, p. 86.

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[1] Mon. U. S. Geol. Survey, No. 39, pl. viii, fig. 15*a*.

[2] Op. sup. cit., pl. viii, fig. 11*a*.

Balanophyllia desmophyllum Milne-Edwards and Haime, 1850, Mon. Brit. Fossil Corals. Palaeontogr. Soc., pp. 35, 36, pl. vi, figs. 1 and 1*a*–1*c*.

Balanophyllia desmophyllum Milne-Edwards and Haime, 1857, Hist. Nat. des Corall., vol. iii, p. 102.

Balanophyllia desmophyllum Quenstedt, 1881, Röhren-u. Sternkorallen, p. 1002.

Balanophyllia desmophyllum Vaughan, 1900, Mon. U. S. Geol. Survey, No. 39, p. 164, pl. xviii, figs. 11–13*a*.

Description.—Corallum subflabelliform, attached by a short pedicel, transverse outline elongate elliptical. Calice rather deep. Septa thin, in five cycles. The members of the first and second cycles with prominent upper margins. The margin of the third also exsert, but not to so great a degree as in the first and second cycles. The members of the fourth cycle have the least prominent margins. Those of the fifth cycle meet and unite in front of the fourth and then fuse to the sides of the third. They are very perforate. Their surfaces are granulate. There are no dissepiments. Costae rather fine, crowded together. Those corresponding to the first, second and third cycles coarser than those corresponding to the fourth and fifth cycles. Those costae corresponding to the fourth and fifth cycles fine, acute, present a serrate appearance when seen from the side, composed of a single row of granules; those corresponding to the first, second and third cycles of septa consist in their lower portion of a single row of granules, but in their upper portion of a double row. Branching by trifurcation. In old specimens the costae of the upper portion are wider and more granulated. Occasionally a septum of the fourth cycle will be fused distally to one of the second cycle and a single costa will correspond to the two septa. The perforations in the intercostal furrows are very close together. Wall rather dense, vesiculated. Epitheca rudimentary or absent. There may be an extremely thin pellicle of epitheca just above the place of attachment. Columella very well developed, spongy, vesiculated.

	1	2	3
	mm.	*mm.*	*mm.*
Greater diameter of calice	14	13	23
Lesser diameter of calice	8.5	8.3	16.5
Height of corallum	18.5	17.5	28.5

The subflabellate form of this species easily separates it from the other older Eocene species of *Balanophyllia* in the United States.

I have compared our American material very carefully with the descriptions and figures of *B. desmophyllum* given by Milne-Edwards and Haime, and when in London, in January, 1898, I had the opportunity to examine the types of the species. I have been unable to find any character by which the American specimens can be separated from those from Bracklesham beds, England. Milne-Edwards and Haime give an account of the affinities of *B. desmophyllum* for the other European species of the genus in their Monograph of the British Fossil Corals. Their work can be consulted for these notes.

Occurrence.—Aquia Formation. 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Genus EUPSAMMIA Milne-Edwards and Haime.

Eupsammia elaborata (Conrad).

Plate LXI, Figs. 12, 13, 13a, 14, 14a.

Turbinolia elaborata Conrad, 1846, Proc. Acad. Nat. Sci. Phila., vol. iii, p. 22, pl. i, fig. 30.

Osteodes elaborata Conrad, 1866, Check List, p. 2.

Osteodes elaborata de Gregorio, 1890, Mon. de la faune éocénique, de l'Ala., p. 25.

(?) *Placosmilia* (*Trochosmilia*) *connivens* De Gregorio, 1890, Mon. de la faune éocénique de l'Ala., p. 255, pl. xliv, figs. 25–28.

Eupsammia elaborata Vaughan, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 6.

Eupsammia elaborata Vaughan, 1896, Bull. 141, U. S. Geol. Survey, p. 90.

Eupsammia elaborata Vaughan, 1900, Mon. U. S. Geol. Survey, No. 39, p. 180, pl. xxi, figs. 3–7.

Description.—The following brief description is based on the original type of Conrad. It bears the label, written by Conrad, "Osteodes elaborata Con., Claiborne, Ala." This specimen is in the Academy of Natural Sciences of Philadelphia.

Corallum compressed, conical, straight; cross-section elliptical, no indication of attachment. Costae rather fine, show perforations; branch by trifurcation. No epitheca. Wall perforate, spongy. Septa thin, in five cycles, anastomosing as usual in Eupsammia. Columella spongy. Greater diameter of calice, 12 mm.; lesser diameter of calice, 9 mm.; length of corallum, 13 mm.

Locality, Claiborne, Alabama.[1]

The following description is based on material from Greggs Landing, Alabama, in the United States National Museum:

The corallum is subconical or subcuneiform, the cross-section is elliptical. The base is rather obtuse, usually rounded; very frequently on the tip is a minute scar, showing that the corallum, in its early stages at least, is attached. The adults are evidently free, and the basal scar may be obliterated. The coralla are usually straight, but sometimes the apex of the base may be nearer to one end of the long transverse axis than to the other. There is no epitheca. The costae correspond to all septa; they are equal, fine and crowded; they are acute, with beaded margins; nearly always have along the summit a single row of granules; extremely rarely the row may be double for a short distance. The septa are thin, weak, arranged in five complete cycles, six systems, with the typical Eupsammid scheme of anastomosing. The granulations on the septal faces are rather low. The columella is lax, spongy, fairly well developed.

	1 *mm.*	2 *mm.*	3 *mm.*
Greater diameter of calice	13	14	12
Lesser diameter of calice	10	11.5	10
Height	17.5	18.5	14+

The specimens from Virginia are usually more slender than those from Alabama. Fig. 12 represents one of these slender specimens.

The following is M. de Gregorio's original description of *Placosmilia* (*Trochosmilia*) *connivens* de Gregorio.

"Tr. conoidea, simplex, elegans, calice elliptico, paulo excavato; septis numerosis in 6 cyclos dispositis, laminaribus, tenuibis, valde angulosis spinulosisque, apud columellam vix incrussatis; columella carente vel cellulosa, ficta; costulis exterioribus confertis, minutis, granulosis."

Translation: "Tr. conoid, simple, elegant; calice elliptical, slightly excavated; septa numerous, disposed in 6 cycles, thin, delicate, with very sharp minute spines, thickening near the columella; columella ab-

[1] Doubtful. It is probable that Conrad has assigned a wrong locality to the specimen.

sent or cellular, false; external costae crowded together, minute, granular."

The description suits *Eupsammia elaborata* except for the number of cycles of septa, and the columella is never absent. *E. elaborata* has only five cycles of septa. M. de Gregorio's figures for the side view of his species, and the outlines of the calice, answer for *E. elaborata,* and only five cycles of septa are represented. In the arrangement of the septa, however, his drawings do not represent what is found in Conrad's species. The septal diagrams given by M. de Gregorio for other species of corals that I know well are not accurate, so it is not improbable that these likewise are not correct representations of what is found in the specimens. I believe that M. de Gregorio has redescribed *E. elaborata.*

Occurrence.—Aquia Formation. Potomac Creek, Aquia Creek, Marlboro Point, Upper Marlboro, 1 mile southeast of Mason Springs.

Collections.—Philadelphia Academy of Natural Sciences, Maryland Geological Survey, Johns Hopkins University.

Eupsammia conradi Vaughan.

Plate LXI, Figs. 15, 15a, 15b.

Turbinolia pileolus Conrad, 1843, Proc. Acad. Nat. Sci. Phila., vol. i, p. 327.
Turbinolia pileolus Conrad, 1846, Proc. Acad. Nat. Sci. Phila., vol. iii, p. 22, pl. i, fig. 26.
Eupsammia (?) *pileolus* Vaughan, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 6.
Eupsammia (?) *pileolus* Vaughan, 1896, Bull. 141, U. S. Geol. Survey, p. 90.
Eupsammia conradi Vaughan, 1900, Mon. U. S. Geol. Survey, No. 39, p. 183, pl. xxi, figs. 10–10*b*.
Not *Turbinolia pileolus* Eichwald, Zool. Spec., pt. i, 1829, p. 186, pl. iii, fig. 1.

Description.—Shape, like a very short cylinder set on a hemisphere. The basal portion is very slightly conical, rounded. Very faint costae. Wall thick, vesiculate. Septa thick, in four cycles; those of the fourth cycle fuse to the sides of the third, near the wall. The first three cycles reach the columella. Sides granulate; columella vesiculate. Greater diameter, 13 mm.; lesser diameter, 11.3 mm.; height, 11 mm.

We know but little of this species; only one specimen seems to have been found, and that one is very unsatisfactory. I have referred it to the genus *Eupsammia* from the strong resemblance of its septal arrange-

ment to that of young forms of other species. There is a faint scar on the base, which may be due to attachment in its early stages. More information concerning this interesting little form will be welcomed.

Occurrence.—Nanjemoy Formation. Pamunkey River, Kent Co., Virginia.

Collection.—Philadelphia Academy of Natural Sciences.

ECHINODERMATA.

Class ECHINOIDEA.

Subclass ECHINOIDEA.

Order SPATANGIDEA.

Family SPATANGIDAE.

A few fragments of the tests of spatangoid forms have been obtained from the Eocene of the Middle Atlantic Slope. It is not possible to determine their generic relations. A single fragment is figured (Plate LXI, Fig. 1).

Occurrence.—Nanjemoy Formation. Evergreen, Va.

Collection.—Johns Hopkins University.

Orders DIADEMATOIDA and CIDAROIDA.

Families DIADEMATIDAE and CIDARIDAE.

Numerous spines belonging either to diadematoid or cidaroid forms have been found in the Eocene deposits of Maryland but they are not sufficiently distinctive to admit of generic determination. A single specimen is figured (Plate LXI, Fig. 2).

Occurrence.—Aquia Formation. Upper Marlboro, Potomac Creek. Sheckels Farm near South River. Severn River.

Collections.—Johns Hopkins University, Maryland Geological Survey.

PROTOZOA.

Class RHIZOPODA.

Order FORAMINIFERA.

Family TEXTULARIDAE.

Genus TEXTULARIA Defrance.

TEXTULARIA GRAMEN d'Orbigny.

Plate LXII, Fig. 1.

Textularia gramen d'Orbigny, 1846, Foram. Fossiles Vienne, p. 248, pl. xv, figs. 4–6.

Textularia gramen Brady, 1884, Chal. Rept., vol. ix, p. 365, pl. xliii, figs. 9, 10.

Textularia gramen Bagg, 1898, Cret. Foram. New Jersey, Bull. 88, U. S. Geol. Survey, p. 29.

Description.—Test arenaceous, rough, stoutly built, laterally compressed, margin subangular; normally composed of five to seven wide chambers (in our Eocene specimens of nine or ten) in each series, which are but slightly convex; posterior end neatly rounded and in general outline very similar to *T. hauerii*, but differing from that species by its more angular lateral edges, and distinguished from *T. abbreviata*, which it also resembles, in being less short and thick.

The little specimens of this Textularia from the localities of the Eocene below agree well in general characteristics with typical forms except in the greater number of chambers. They are composed of finely agglutinated grains well-rounded and smoothed over and the shells are quite compactly built for this species. The sutures are slightly depressed giving thus some relief to the chambers, especially to the final ones. This is a rare form in the Eocene of Maryland though common in the Miocene of Virginia. In present oceans it occurs in nearly all latitudes but is commonest on shallow bottoms.

Occurrence.—AQUIA FORMATION. Upper Marlboro, 1 mile northeast of Piscataway.

Collections.—Maryland Geological Survey, Johns Hopkins University.

Textularia sagittula Defrance.

Plate LXII, Fig. 2.

Textularia sagittula Defrance, 1824, Dict. Sci. Nat., vol. xxxii, p. 177; 1828, vol. liii, p. 344; Atlas Conch., pl. xiii, fig. 5.

Textularia sagittula Brady, 1884, Chal. Rept., vol. ix, p. 361, pl. xlii, figs. 17, 18.

Textularia sagittula Bagg, 1898, Bull. Amer. Pal., No. 10, p. 20.

Description.—Test elongated, strongly compressed, with sharp-angled peripheral margin; chambers numerous, about ten to twelve in each series in typical forms, closely set, separated by short, nearly straight septal lines externally visible; aperture linear.

Specimens of this form occur also in the Cretaceous (Rancocas) of New Jersey. It is rare in the Eocene of Maryland as are all species of the Textularia type. Three specimens have been recognized from Upper Marlboro. In present oceans this is one of the most wide-spread and commonest of all the Textularidae and Brady states that the same is true among the fossil Foraminifera. This may be attributed to the thick and solid walls, which, though not definitely arenaceous are so compactly built of opaque material that they are more readily preserved than more delicate types. It is a shallow water species of temperate seas but is reported by Professor Brady to occur in the North Atlantic at the depth of 2675 fathoms and at 1425 fathoms in the South Atlantic.

It occurs in the fossil condition in the Cretaceous formations of the north of Ireland (Wright), in the Cretaceous of New Jersey, the Eocene of the London Basin (Jones, Parker and Brady), the Lower Eocene of the Thanet beds of Pegwell Bay (Burrows), the Miocene of Austria, France, and elsewhere (d'Orbigny, Czjek, etc.), Miocene of Maryland and Virginia (Bagg), the later Tertiaries in Italy (Defrance, Jones and Parker, d'Orbigny), the Crag of England (Jones, Parker and Brady), and the Post-Tertiary beds of Norway, Scotland, and Ireland (Sars, Robertson, Wright).

Occurrence.—Aquia Formation. Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Textularia subangulata d'Orbigny.

Plate LXII, Fig. 3.

Textularia subangulata d'Orbigny, 1846, Foram. Fossiles Vienne p. 247, pl. xv, figs. 1–3.

Textularia subangulata Egger, 1857, Neues Jahrb. für Min. etc., p. 293, pl. xii, figs. 15, 16.
Textularia subangulata Bagg, 1898, Bull. Amer. Pal. No. 10, p. 20.

Description.—The test of *Textularia subangulata* closely resembles *T. gramen*, but it is separated from that species by the more nearly straight sutures, more angular edges, and in typical forms by its larger number of chambers. The one specimen of this form from the Brook's Estate near Seat Pleasant, while it may possibly be considered as a variety of the more widespread *T. gramen* differs so markedly from the common form that it has been placed with the present species.

d'Orbigny's specimens came from the Miocene of Austria, Egger's from the Miocene of Ortenburg.

Occurrence.—Aquia Formation. Brooks Estate near Seat Pleasant.

Collection.—Johns Hopkins University.

Genus SPIROPLECTA Ehrenberg.

Spiroplecta clarki Bagg.

Plate LXII, Fig. 4.

Spiroplecta clarki Bagg, 1895, Johns Hopkins Univ. Circ., vol. xv, p. 5.
Spiroplecta clarki Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 91.
Spiroplecta clarki Bagg, 1898, Bull. Amer. Pal., No. 10, p. 20, pl. i, fig. 1.

Description.—Test elongate, textulariform, finely arenaceous, firmly cemented; compressed strongly, lateral margins sharp and very slightly lobed; surface of shell rough, of a dull gray color; chambers at first planospiral then biserially arranged with nine and ten respectively on each side; aperture a median arched opening; length, 0.53 mm.; breadth, 0.20 mm.

Previous to the author's discovery of the above Foraminifera the genus *Spiroplecta* has never been reported from the Tertiary formation so far as known. It has, however, been described from the Cretaceous of Mississippi (Ehrenberg), and of Minnesota (Woodward and Thomas), and from the Gault and Chalk of England (Parker and Jones). Brady reports its occasional presence in existing oceans confined to three species, *S. annectens*, *S. biformis*, and *S. americana*, the latter found living only in one locality off Raine Island, Torres Strait at the depth of 155 fathoms.

Joseph Wright includes the genus *Spiroplecta* in the list of Post-Tertiary Foraminifera from the North of Ireland.

The two specimens which the writer found at Woodstock seem to be new though they resemble *S. biformis* of Parker and Jones. They are separated from that species, however, by their sharp angular edges.

The distal end is more obtusely rounded than in Textularian types and the chambers are less regularly developed.

Occurrence.—NANJEMOY FORMATION. Woodstock.

Collection.—Johns Hopkins University.

Family LAGENIDAE.

Subfamily NODOSARIDAE.

Genus NODOSARIA Defrance.

NODOSARIA AFFINIS (d'Orbigny).

Plate LXII, Fig. 5.

Dentalina affinis d'Orbigny, 1840, Mem. Soc. Géol. France, vol. iv, p. 13, pl. i, fig. 4.
Nodosaria affinis Sherborn and Chapman, 1886, Jour. Roy. Microsc. Soc., 2nd series, vol. vi, p. 748, pl. xiv, fig. 33.
Nodosaria affinis Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 91.
Nodosaria affinis Bagg, 1898, Bull. Amer. Pal., No. 10, p. 24.

Description.—Test very large, nearly straight, more tapering than *Nodosaria bacillum*, and without having the primordial chamber larger than the succeeding one; proximal end acuminate; chambers numerous, unconstricted below but becoming distinctly so above; surface marked by about ten distinct elevated costae as in *N. bacillum;* aperture central, elevated on the ultimate chamber. Length 9 mm. or more.

Occurrence.—NANJEMOY FORMATION. Woodstock.

Collection.—Johns Hopkins University.

NODOSARIA BACILLUM Defrance.

Plate LXII, Fig. 6.

Nodosaria bacillum Defrance, 1825, Dict. Sci. Nat., vol. xxxv, p. 127; vol. xxxvi, p. 487, Atlas Conch., pl. xiii, fig. 4.
Nodosaria bacillum Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 91.
Nodosaria bacillum Bagg, 1898. Bull. Amer. Pal., No. 10, p. 24.

Description.—Test very large, straight or nearly so, surface marked by about ten very distinct snow-white costae, though this number does

not remain constant, some specimens having only eight costae below and as many as twelve above; primordial chamber bulbous, acuminate, though the spine is frequently broken; segments regular, less distinct below, marked by straight, transverse septae; length unknown but fragments of nine chambers measure 5 mm.

This *Nodosaria* has been described from a number of Tertiary deposits of Europe and England but is seldom found in modern oceans, though Schlumberger mentions it from the Gulf of Gascony.

It is, like all *Nodosaria*, not at all common in the Eocene deposits of the Middle Atlantic Slope.

Occurrence.—Nanjemoy Formation. Woodstock. Aquia Formation. 3 miles west of Leeland, 2 miles below Potomac Creek, 1 mile southeast of Mason Springs, Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Nodosaria communis (d'Orbigny).

Plate LXII, Fig. 7.

Dentalina communis d'Orbigny, 1826, Ann. Sci. Nat., vol. vii, p. 254.

Dentalina communis Jones and Parker, 1860, Quart. Jour. Geol. Soc. London, vol. xvi, pl. xix, figs. 25, 26.

Nodosaria communis Brady, 1884, Chal. Rept., vol. ix, p. 504, pl. lxii, figs. 19–22.

Nodosaria communis Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 91.

Nodosaria communis Bagg, 1898, Bull. Amer. Pal., No. 10, p. 25.

Description.—Test elongate, smooth, with depressed, oblique septa; primordial chamber larger than the one succeeding and in some of our specimens acuminate; ultimate chamber, elongate, tube-like; transverse section circular, aperture round, smooth, length 0.6 mm. The earlier description of this species was based on a single young form but since this time a number of other specimens have been found from Upper Marlboro. The typical forms of this species have the sutures depressed and the chambers all oblique, in some of the forms remarkably so.

This is one of the most common *Nodosaria* in both fossil and recent state and has a world-wide distribution to-day. It includes a large number of variously described species with oblique sutures such as *D. inornata*, and *D. badenensis*, d'Orbigny (Vienna Basin Monograph), *D. legumen* Reuss, *D. subarcuata* Williamson and many others.

Occurrence.—AQUIA FORMATION. Brooks Estate near Seat Pleasant, Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey.

NODOSARIA CONSOBRINA VAR. EMACIATA (Reuss).

Plate LXII, Fig. 8.

Dentalina consobrina var. emaciata Reuss, 1865, Denkschr. d. k. Akad. Wiss. Wien, vol. xxv, p. 132, pl. ii, figs. 12, 13.

Nodosaria consobrina var. emaciata Brady, 1884, Chal. Rept., vol. ix, p. 502, pl. lxii, figs. 25, 26.

Nodosaria consobrina var. emaciata Bagg, 1898, Bull. Amer. Pal., No. 10, p. 25.

Description.—Test smooth, elongate, tapering gracefully, segments numerous, short, elongate oval; similar in outline to *N. consobrina* but more elongated and slender; septae somewhat depressed, transverse. The proximal chamber is rounded and ends in a nipple-shaped aperture.

Both *N. consobrina* and the variety *emaciata* are found living in the North Atlantic at depths ranging from 290 to 725 fathoms, and in the South Atlantic at 350 fathoms; off the Cape of Good Hope, 150 fathoms; and in the South Pacific, 129-1375 fathoms.[1]

This species has a wide distribution in the fossil world. It is found in several formations of the New Jersey Cretaceous, according to Wright it occurs in the Chalk of Ireland, Jones and Parker report it in the London Clay, Reuss, Bornemann, etc., record it in the Septaria Clays of Germany, the Miocene of Austria (d'Orbigny), the later Tertiaries of Italy (Costa), the Post-Tertiary of Norway (Crosskey and Robertson), the Island of Ischia (Broeck), and in Scotland (Robertson).

Occurrence.—AQUIA FORMATION. Upper Marlboro.

Collection.—Johns Hopkins University.

NODOSARIA SANDBERGERI (Reuss).

Plate LXII, Fig. 9.

Dentalina sandbergeri Reuss, 1856, Sitzungsb. k. Akad. Wiss. Wien, vol. xviii, p. 224, pl. i, fig. 5.

Description.—Test stoutly built, composed of from four to eight chambers which are constricted at the sutures; primordial chamber larger

[1] Brady, Chal. Rept., p. 502.

than the one succeeding, ultimate chamber largest; chambers more constricted towards the oral end and none of them quite so strongly distinct as in Reuss' figure. Surface of shell strongly costate but differing from Reuss' specimens in that most of our forms have no costae upon the final segment, though this feature is not constant enough to make a new variety. The aperture is situated upon one side as in Marginulina types.

Reuss' specimens were from the Tertiary deposits of Germany.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Nodosaria obliqua (Linné).

Plate LXII, Fig. 10.

Nautilus obliquus Linné, 1767, Syst. Nat., 12th Edit., p. 1163, No. 281; 1788, Syst. Nat., 13th Edit. (Gmelin's), p. 3372, No. 14.

Nodosaria obliqua Brady, 1884, Chal. Rept., vol. ix, p. 1513, pl. lxiv, figs. 20–22.

Description.—Test variable in size, sometimes very large, elongate. tapering, arcuate; septal lines depressed, surface costate, costae varying in size and number in different specimens; chambers numerous, ventricose, distinct; aperture central, radiate.

According to Professor Brady this species is found in every sea and at all depths from the laminarian zone down to 1500 or 2000 fathoms.

It occurs frequently in the fossil state: Cretaceous of Sweden (Nillson), Cretaceous of Mecklenburg, and elsewhere (Reuss), Cretaceous of New Jersey (Bagg), Lower Eocene, Thanet Beds, Pegwell Bay (Burrows), Tertiary of Germany (Reuss, etc.), Tertiary of Italy (Costa). Many other references could easily be given though these are sufficient to show its wide distribution.

These forms are so large and long that one can find no perfect specimens as they are easily broken in collecting and washing the marl. The Cretaceous forms from New Jersey, however, are frequently perfect and well preserved.

Occurrence.—Aquia Formation. Upper Marlboro (fragments only).

Collection.—Maryland Geological Survey.

Genus VAGINULINA Lamarck.

Vaginulina legumen (Linné).

Plate LXIII, Fig. 1.

Nautilus legumen Linné, 1758, Syst. Nat., 10th Edit., p. 711, No. 248; 12th Edit., 1767, p. 1164, No. 288.

Vaginulina legumen Brady, 1884, Chal. Rept., vol. ix, p. 530, pl. lxvi, figs. 13–15.

Vaginulina legumen Bagg, 1898, Bull. Amer. Pal., No. 10, p. 26.

Vaginulina legumen Bagg, 1898, Cret. Foram. New Jersey, Bull. 88, U. S. Geol. Survey, p. 52, pl. iv, fig. 4.

Description.—Test nearly straight, pod-like, compressed, smooth, consisting of only six chambers; septa limbate, parallel, oblique, less distinct towards the distal end; ultimate chamber slightly prolonged at the anterior end; aperture radiate; length, 0.80 mm.

The genus *Vaginulina* is closely related to the ensiform varieties of *Cristellariae* and to the less flattened form *Marginulina*, and from the curved forms of *Nodosaria* from which it is separated by its broader outline and marginal aperture.

Brady states that it is widely distributed over present oceans and that the genus reaches its greatest abundance in the North Atlantic. The species *V. legumen* is found at various depths down to 2000 fathoms but it is commonest in shallow waters.

Tate and Blake record this form from the Yorkshire Lias, Jones and Parker include it in the forms from the Upper Trias (?) of Chellaston, near Derby; Chapman records its occurrence from the Gault of Folkestone; Burrows, Sherborn and Bailey record it from the Red Chalk of Yorkshire, etc., and many other localities are elsewhere given.

Occurrence.—Aquia Formation. Brooks Estate near Seat Pleasant.

Collection.—Johns Hopkins University.

Genus MARGINULINA d'Orbigny.

Marginulina costata (Batsch).

Plate LXIII, Figs. 2, 3.

Nautilus (Orthoceras) costatus Batsch, 1791, Conchyl. des Seesandes, p. 3, pl. i, figs 1*a*–*g*.

Marginulina costata Brady, 1884, Chal. Rept., vol. ix, p. 528, pl. lxv, figs. 10–13.

Description.—Test rather stoutly built, irregularly costate and costae curving about the distal end; compressed but not strongly so; consist-

ing of six chambers, largest and most distinct at oral end, bluntly acuminate, aperture on incurved side of final chamber.

Brady says of this form, "Individual specimens vary a good deal in contour, and also as to the number and degree of development of the superficial ribs; but the stout proportions of the shell, its subcylindrical form, and comparatively slight curvature, the inflated character of the later chambers, and the marginal aperture, are generally sufficient to distinguish it from costate varieties of *Vaginulina* and *Cristellaria*. The test is usually more or less compressed just at the commencement, and occasionally presents a sharp or even subcarinate edge at the aboral end, but more frequently the margin is rounded from the beginning."

It is found in many parts of the North Atlantic at depths ranging from 370 to 1240 fathoms, from the South Atlantic at still greater depths, from the Mediterranean, and from the Adriatic. Save a few specimens found at 150 fathoms off the coast of New Zealand, it has not been observed in any portion of the Pacific ocean, in the Southern ocean or the Red Sea.

Occurrence.—Aquia Formation. Upper Marlboro.

Collection.—Maryland Geological Survey.

Genus CRISTELLARIA Lamarck.

Cristellaria gibba d'Orbigny.

Plate LXIII, Fig. 4.

Cristellaria gibba d'Orbigny, 1839, Foram. Cuba, p. 63, pl. vii, figs. 20, 21.

Cristellaria excisa Bornemann, 1855, Zeitschr. d. deutsch. geol. Gesell., vol. vii, p. 328, pl. xiii, figs. 19, 20.

Cristellaria pulchella Reuss, 1862, Sitzungsb. d. k. Akad. Wiss. Wien, vol. xlvi, p. 71, pl. viii, fig. 1.

Robulina concinna Reuss, 1863, Sitzungsb. d. k. Akad. Wiss. Wien, vol. xlviii, p. 52, pl. v, fig. 58.

Cristellaria gibba Bagg, 1898, Cret. Foram. New Jersey, Bull. 88, U. S. Geol. Survey, p. 56.

Description.—Test oblong, biconvex, smooth, subcarinate, narrow; chambers few (seven or eight), slightly arcuate, separated by distinct septa; aperture marginate. Length (Cretaceous), 1.3 mm.; breadth, 0.87 mm. The septal face is rather sharply cut off from the whole surface and this feature separates it from *Cristellaria acutauricularis* which it

closely resembles. Our Eocene forms have more chambers than the Cretaceous specimens of New Jersey which show nine. The mouth opening is also more prolonged and the sutures somewhat depressed between the chambers.

This species is found in many places in the Cretaceous of New Jersey, Rancocas (Bagg), Septaria Clays near Berlin (Bornemann), North German Hils and Gault (Reuss), and elsewhere.

We must regard the species as an intermediate variety between the elongate compressed *Cristellaria crepidula,* and the symmetrical lenticular *Cristellaria rotulata.* The form occurs in the North Atlantic and in the South Pacific at depths of less than 500 fathoms (Brady).

Occurrence.—Aquia Formation. 1 mile northeast of Piscataway, Upper Marlboro.

Collection.—Maryland Geological Survey.

Cristellaria rotulata (Lamarck).

Plate LXIII, Fig. 5.

Lenticulites rotulata Lamarck, 1804, Annales du Museum, vol. v, p. 188, No. 3.—Tableau Encycl. et Meth., pl. cccclxvi, fig. 5.

Cristellaria rotulata d'Orbigny, 1840, Mém. Soc. géol. France, vol. iv, p. 26, pl. ii, figs. 15–18.

Cristellaria rotulata Parker and Jones, 1865, Phil. Trans., vol. clv, p. 345, pl. xiii, fig. 19.

Description.—Test involute, biconvex, smooth; peripheral margin sharp, non-carinate; chambers numerous, eight or nine in final convolution; septa gracefully curved, visible externally as fine lines; aperture elliptical radiate. Diameter, 1-2 mm.

While the above species is abundant in the Cretaceous of New Jersey and in the Rancocas reaching a large size for this type, it and all other *Cristellariae* are exceedingly scarce in the overlying Eocene. The type secured from Mason Springs is very large and thick-shelled. Since such a form would be readily preserved it is difficult to account for the lack of the species elsewhere while so many much more delicate Foraminifera abound.

It is doubtful if any Foraminifera is more widely distributed or more abundant either living or in fossil state than *Cristellaria rotulata.*

Brady records its presence in Arctic waters and as far south as Terra del Fuego and at the same time it occurs at all possible depths down to 2200 fathoms. So in the fossil world it is equally widely distributed. Jones and Parker record it in the Upper Trias of Derbyshire; Brady and Blake have identified it in every division of the Lias of England. It is frequently reported in the Cretaceous of England (Sherborn, Chapman, Wright, Sowerby, etc.). It is abundant in every division of the Tertiary and has been frequently recorded.

Occurrence.—Aquia Formation. Upper Marlboro, 1 mile southeast of Mason Springs.

Collection.—Maryland Geological Survey.

Cristellaria radiata (Bornemann).

Plate LXIII, Fig. 6.

Robulina radiata Bornemann, 1855, Zeitschr. d. deutsch. geol. Gesell., vol. vii, p. 334, pl. xv, fig. 1.
Cristellaria radiata Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 91.
Cristellaria radiata Bagg, 1898, Bull. Amer. Pal., No. 10, p. 29, pl. i, fig. 3.

Description.—Test nearly circular, moderately compressed, with circular raised umbilicus; final convolution showing ten strongly curved, even chambers, marked externally by raised white septal lines which become less distinct toward the peripheral margin; keel quite definite and of the same snow-white character and color as the raised septa, while the chambers are darker in color and are strongly contrasted from the rest of the shell. The surface is smooth and glistening; the aperture radiate; diameter, 1.26 mm.

Bornemann's specimens of *Cristellaria radiata* were from the Oligocene (Septarienthon) of Germany. This form resembles *Cristellaria rotulata* but has the umbilicus raised, and the septa are also raised as they are not in *Cristellaria rotulata.* The keel is definite but not produced into a flange as in *Cristellaria cultrata* which form it closely resembles.

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Johns Hopkins University.

Genus POLYMORPHINA d'Orbigny.

POLYMORPHINA AUSTRIACA (d'Orbigny).

Plate LXIII, Fig. 7.

Guttulina austriaca d'Orbigny, 1846, Foram. Fossiles Vienne, p. 223, pl. xii, figs. 23–25.

Polymorphina austriaca Schwager, 1877, Boll. R. Com. geol. Ital., vol. viii, p. 25, pl. xxxi.

Polymorphina austriaca Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 91.

Polymorphina austriaca Bagg, 1898, Bull. Amer. Pal., No. 10, p. 28.

Description.—Test oviform, smooth, moderately compressed, acuminate anteriorly; consisting of four chambers which are oblong, oblique, and somewhat convex; separated by fairly deep sutures; aperture mammillate.

d'Orbigny considers that *Guttulina nitida* is closely related to this species but states that it differs from it in its more elevated chambers. Our specimens are slightly more acuminate posteriorly than in d'Orbigny's figure. Professor Brady lists this form among the synonyms of *Polymorphina problema* but d'Orbigny has shown that it differs from the latter by its more convex chambers and more gibbous form as a whole. Since the specific variations among the *Polymorphinae* are necessarily limited there is a possible danger of including too many variations under one species and it is preferable, therefore, to keep the species distinct as d'Orbigny has done.

d'Orbigny's specimens were from the Miocene of Nussdorf, Baden. It is not a common fossil form but Terquem has identified it among the Eocene Foraminifera of the Paris Basin.

Occurrence.—NANJEMOY FORMATION. Woodstock.

Collection.—Johns Hopkins University.

POLYMORPHINA COMMUNIS (d'Orbigny).

Plate LXIII, Figs. 8, 9.

Guttulina communis d'Orbigny, 1826, Ann. Sci. Nat., vol. vii, p. 266, No. 15, pl. xii, figs. 1–4. Modele, No. 62.

Polymorphina communis Brady, 1884, Chal. Rept., vol. ix, p. 568, pl. lxxii, fig. 19.

Polymorphina communis Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.

Polymorphina communis Bagg, 1898, Bull. Amer. Pal., No. 10, p. 29.

Description.—Test irregular, ovoidal, or egg-shaped; consisting of four or five distinct chambers; anterior end extremely acute, posterior obtuse;

chambers inflated, elliptical, embracing; surface smooth with definite septal depressions; aperture mammillate; diameter, 0.35 mm.

This species occurs abundantly in the New Jersey Cretaceous but the forms are much larger than in the Eocene of Maryland. The species also occurs in the Pamunkey formation of Virginia on the Pamunkey River.

This form is recorded from the Lower Lias (Blake); Septaria Clays of Germany (Reuss); Gault of Folkestone (Chapman); Lower Eocene of Pegwell Bay (Burrows); Red Chalk of Yorkshire, etc. (Burrows, Sherborn and Bailey); and many other references.

Polymorphina communis is closely related to *Polymorphina problema*, and Professor Brady thinks that they should be united under one name of *P. problema* and the name *communis* be allowed to drop. In the original models described by d'Orbigny (Nos. 61 and 62), the forms portrayed represent clearly distinct species, the first *P. problema* shows about seven definite segments which are much inflated and with deep sutures while *P. communis* presents about four or five segments with less excavated sutures.

In d'Orbigny's great monograph on the Vienna Basin, both forms are included and the rather unimportant distinctions here seem to be that *P. communis* is of smaller size, the superior end acuminate and the sutures are complanate while *P. problema* shows an obtuse anterior, excavated sutures, larger size and more inflated chambers.

Reuss considered in his notes on Herr von Schlicht's Septaria-clay Foraminifera that *P. communis* is a variety of *P. problema* and his conclusion may be accepted ultimately, though for the present, it seems better to keep them distinct.

Both forms have a wide distribution throughout all oceans but are apparently limited to a depth of less than 155 fathoms and so are shallow water forms. It is also interesting to note that in the fossil world they frequently occur side by side and are variously described from the same localities.

The genus *Polymorphina* is represented by a good many forms of Foraminifera as compared with other types but they never become abundant as do some of the involute genera.

Occurrence.—NANJEMOY FORMATION. Woodstock. AQUIA FORMATION. Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey.

POLYMORPHINA COMPRESSA d'Orbigny.

Plate LXIII, Fig. 10.

Polymorphina compressa d'Orbigny, 1846, Foram. Fossiles Vienne, p. 253, pl. xii, figs. 32–34.

Polymorphina compressa Brady, Parker and Jones, 1870, Trans. Linn. Soc. London, vol. xxvii, p. 227, pl. xl, fig. 12, *a–f*.

Polymorphina compressa Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.

Polymorphina compressa Bagg, 1898, Bull. Amer. Pal., No. 10, p. 29, pl. iii. fig. 1.

Description.—The shell or test of *Polymorphina compressa* is oblong, flatly compressed, inequilateral, with numerous fusiform chambers arranged in a double series. These are somewhat inflated and the sutures depressed. The surface of the shell is sometimes beautifully striated longitudinally, at others smooth or faintly striated. The aperture is variable, sometimes labyrinthic or porous but usually simple, circular and coronate. Its length is very variable, in our specimens from 0.82 to 1.3 mm., with a breadth of 0.43 mm.

This species is very common in the Miocene of Maryland at Plum Point, Jones Wharf, etc., and also in the Miocene of Virginia. It is, however, not abundant in the Eocene. It has been identified from a well-boring in Norfolk, Va., at a depth of 685 feet. Professor Brady compares this form with its relatives as follows:

"In general terms *Polymorphina compressa* may be said to include the less regularly Textulariform varieties of the genus, its nearest allies being *Polymorphina complanata* d'Orbigny; *Polymorphina frondiformis* S. V. Wood; and *Polymorphina cylindroides* Roemer. Of these the first is distinguished by an exceedingly regular and equilateral Textularia-like disposition of the segments, and *Polymorphina frondiformis* by its even larger dimensions and its surface-ornament of interrupted costae or tubercles; whilst *Polymorphina cylindroides* has a long tapering test, less compressed than that of the present species and composed of a small number of nearly erect segments.

"*Polymorphina compressa* is a cosmopolitan form, especially common in temperate latitudes. . . . It is abundant in the temperate portion of the North Atlantic, preferring shallow-water margins, but extending sometimes to a depth of 400 to 600 fathoms. In the tropical South Atlantic and in the North and South Pacific it is less frequent.

"It has been recognized as a fossil in the lower and middle Lias of the west and north of England (Brady, Blake); in the lower Oolite, the Upper Oxford Clay, and the Kimmeridge Clay of England (Parker and Jones), and in the Cretaceous system of England, France, Germany, and North America, and generally in the Tertiary and Post-Tertiary formations of Europe."

Occurrence.—NANJEMOY FORMATION. Woodstock, Well at Chesapeake Beach at 90-92 feet.

Collections.—Johns Hopkins University, Maryland Geological Survey.

POLYMORPHINA ELEGANTISSIMA Parker and Jones.

Plate LXIII, Fig. 11.

Polymorphina elegantissima Parker and Jones, 1865, Phil. Trans., vol. clv, p. 438, table 10.

Polymorphina elegantissima Brady, Parker and Jones, 1870, Trans. Linn. Soc. London, vol. xxvii, p. 231, pl. xl, fig. 15, *a–e*.

Polymorphina elegantissima Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.

Polymorphina elegantissima Bagg, 1898, Bull. Amer. Pal., No. 10, p. 30.

Description.—Test ovoidal, anterior end acute, posterior obtusely rounded; chambers four or five, elongate, arranged in an inequilateral biserial manner and overlapping in such a way that while one side remains nearly flat the opposite is more or less irregularly vaulted and shows all the chambers in parallel arrangement; final segment broad below, embracing, and bearing the mammillate aperture upon the anterior end. Shell surface smooth, finely perforate; length, 0.60 mm.; breadth, 0.40 mm.

Professor Brady places under this species the form *P. problema* var. *deltoidea* Reuss, and *P. anceps* Reuss.

Occurrence.—NANJEMOY FORMATION. Woodstock.

Collection.—Johns Hopkins University.

POLYMORPHINA GIBBA (d'Orbigny).

Plate LXIII, Fig. 12.

Globulina gibba d'Orbigny, 1846, Foram. Fossiles Vienne, p. 227, pl. xiii, figs. 13, 14.
Polymorphina gibba Brady, 1884, Chal. Rept., vol. ix, p. 561, pl. lxxi, fig. 12.
Polymorphina gibba Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.
Polymorphina gibba Bagg, 1898, Bull. Amer. Pal., No. 10, p. 30.

Description.—Test subglobular, apex slightly produced; base obtusely rounded; consisting of from two to four chambers compactly joined and overlapping. The surface is smooth and unmarked by septal constrictions. Septa visible as delicate, oblique lines; transverse section nearly circular; aperture mammillate; length of our specimens, 0.35 mm.; breadth, 0.30 mm.

This is not a common species in the Eocene but the specimens are very similar to those from the Navesink formation (Lower Marl Bed) of the New Jersey Cretaceous.

This form is very similar to *Polymorphina lactea* from which it is with difficulty separated. Its distribution is probably the same, both recent and fossil.

Occurrence.—NANJEMOY FORMATION. Woodstock. AQUIA FORMATION. Upper Marlboro, Brooks Estate near Seat Pleasant.

Collections.—Johns Hopkins University, Maryland Geological Survey.

POLYMORPHINA LACTEA (Walker and Jacob).

Plate LXIII, Fig. 13.

Serpula lactea Walker and Jacob, 1798, Adam's Essays (Kanmacher's Edit.) p. 634, pl. xxiv, fig. 4.
Polymorphina lactea Williamson, 1858, Recent Foram. Gt. Brit., p. 71, pl. vi, fig. 147.
Polymorphina lactea Brady, Parker and Jones, 1870, Trans. Linn. Soc. London, vol. xxvii, p. 213, pl. xxxix, fig. 1, *a–c*.

Description.—Test ovate or subpyriform, only slightly depressed, consisting of three or four chambers with flush sutures and scarcely distinct septal lines; aperture terminal, radiate; diameter, 0.39 mm. (Miocene).

It is, as pointed out above, very difficult to separate this form from *P. gibba*. It is somewhat more graceful and slender and less obtuse and the writer believes that there is less good ground for separating these two forms than for distinguishing *Polymorphina communis* and *Poly-*

morphina problema. The description of this form precedes *P. gibba* by nearly 50 years and if any change is made this must be given the preference and *P. gibba* be made a variety of *Polymorphina lactea.* Inasmuch as there is just as great danger of placing together many forms with varietal distinctions as there is in making too many species it is not attempted at the present time to change previous determinations and specific names. While found in almost every sea it is more abundant in the shallow waters of temperate latitudes. It was not dredged by the Challenger in the North Atlantic at a greater depth than 400 fathoms but in the South Atlantic was found at 1990 fathoms, North Pacific at 2300 fathoms, South Pacific, 2350; but in all these cases the specimens are rare and of exceedingly small size, showing that they belong to shallow water temperate zoneal forms. Its geological range is likewise wide and has been repeatedly recorded from the Jura, Cretaceous, and the various Tertiary deposits. It has been found in the Miocene of Plum Point, where it is rare.

Occurrence.—AQUIA FORMATION. Upper Marlboro.

Collection.—Maryland Geological Survey.

POLYMORPHINA PRAELONGA Terquem.

Plate LXIII, Fig. 14.

Polymorphina praelonga Terquem, 1878, Mém. Soc. géol. France, series 3, vol. i, p. 39, pls. iii, viii, figs. 20, 21.

Polymorphina praelonga Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.

Polymorphina praelonga Bagg, 1898, Bull. Amer. Pal., No. 10, p. 31.

Description.—Test elongate oval, attenuated anteriorly; smooth and glistening; nearly circular in transverse section; three or four slightly raised, elongate chambers marked by somewhat depressed septa. Length, 0.79 mm.

This species, with its many varieties of form, is beautifully illustrated in Terquem's Monograph on the Eocene Foraminifera about Paris.

It is said to be more abundant in the Eocene but quite rare in deposits of (later) Pliocene age.

Occurrence.—NANJEMOY FORMATION. Woodstock.

Collection.—Johns Hopkins University.

Family GLOBIGERINIDAE.

Genus GLOBIGERINA d'Orbigny.

Globigerina bulloides d'Orbigny.

Plate LXIII, Figs. 15, 16, 16a.

Globigerina bulloides d'Orbigny, 1826, Ann. Sci. Nat., vol. vii, p. 277, No. 1; Modeles, No. 17 (young), and No. 76.

Globigerina bulloides d'Orbigny, 1846, Foram. Fossiles Vienne, p. 163, pl. ix, figs. 4–6.

Globigerina bulloides Brady, 1884, Chal. Rept., vol. ix, p. 593, pl. lxxvii, and pl. lxxix, figs. 3–7.

Globigerina bulloides Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.

Globigerina bulloides Bagg, 1898, Bull. Amer. Pal., No. 10, p. 33.

Description.—"Test spiral, subtrochoid; superior surfaee convex, inferior more or less convex but with deeply-sunken umbilieus; periphery rounded, lobulated; adult specimens eomposed of about seven globose segments, of whieh four form the outer convolution, the aperture of the individual chambers opening independently into the umbilieal vestibule; diameter sometimes one-fortieth of an ineh (0.63 mm.), but oftener mueh less." (Brady, loe. eit.)

While this speeies is not uneommon in the New Jersey Cretaceous it is rare in the Eoeene. In New Jersey in the Manasquan (Upper Marl Beds) formation it is however much larger than in the Rancocas, and is 0.4 mm. in diameter in some speeimens.

In the Mioeene of Maryland and Virginia it is also rather eommon but it is most abundant in the Miocene shell marls of Plum Point.

In present oeeans this speeies of *Globigerina* is the eommonest of all the *Globigerinidae.* In temperate zones it exists in enormous abundanee and it does not seem to be limited in depth but oeeurs in dredgings all the way from shallow bottoms to the greatest depths. It is one of the few foraminifera which are truly pelagic in habit, that is, exist at the surface or in mid-water, for strange as it may seem, the majority of genera pass their existence at or near the bottom. Notwithstanding this faet that the great majority of foraminifera pass their existenee near the bottom, the surfaee and middle water forms, far surpass the former in point of numbers and are present in eountless millions in all great oeeans. It is interesting to note what genera and species belong

to these surface forms and Professor Brady has prepared a list to show this feature. In this list we find seven species of *Globigerinae*, *Orbulina universa*, *Hastigerina pelagica*, *Pullenia obliquiloculata*, *Sphaeroidina dehiscens*, *Candeina nitida*, six species of *Pulvinulina*, *Cymbalopora bulloides* and *Chilostomella ovoidea* Reuss.

Occurrence.—Nanjemoy Formation. Woodstock, Well at Chesapeake Beach at 90-92 feet.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Family ROTALIDAE.

Genus DISCORBINA Parker and Jones.

Discorbina bertheloti (d'Orbigny).

Plate LXIV, Fig. 1.

Rosalina bertheloti d'Orbigny, 1839, Foram. Canaries, p. 135, pl. i, figs. 28–30.
Discorbina bertheloti Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.
Discorbina bertheloti Bagg, 1898, Bull. Amer. Pal., No. 10, p. 34.

Description.—Test very compressed, carinate, finely punctate; spiral side approximately flat, reverse side low-convex; chambers depressed, numerous, convex, margins slightly limbate; ultimate chamber larger than the one preceding. The shell is quite similar to *Truncatulina lobatula*, but it is more depressed, and the walls are more finely perforate; diameter, 0.42 mm.

This is a shallow-water foraminifera occurring usually at depths of less than 500 fathoms.

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Johns Hopkins University.

Discorbina turbo (d'Orbigny).

Plate LXIV, Fig. 2.

Rotalia (*Trochulina*) *turbo* d'Orbigny, 1826, Ann. Sci. Nat., vol. vii, p. 274, No. 29; Modele, No. 73.
Discorbina turbo Parker, Jones and Brady, 1865, Ann. and Mag. Nat. Hist., series 3, vol. xvi, p. 30, pl. ii, fig. 68.
Discorbina turbo Brady, 1884, Chal. Rept., vol. ix, p. 642, pl. lxxxvii, figs. 8, *a*, *b*, *c*.

Description.—Test solidly built in a compact involute subconical form; walls rather coarsely perforated; six chambers visible on inferior surface

with straight depressed septa between them and with the margin slightly lobulated at their extremities. The inferior surface is flat or nearly so; superior side convex and several (three?) convolutions indistinctly visible.

Septal lines rather sharply and gracefully curved and less definite as the primordial chamber is reached, which makes it difficult to tell how many chambers are present. Peripheral view a definite cone and aperture lying underneath the margin. Shell is of small size but is very abundant in the Lower Eocene.

This species is found in the Chalk of Maastricht (Parker and Jones), the Eocene of Paris (Terquem), etc.

It is a shallow-water foraminifera as is proved by the Challenger expedition which obtained the form at 420 fathoms (Ascension Island small forms), 350 fathoms off the coast of South America, at from two to ten fathoms at Port Jackson, Australia, and in the Bermuda coral sands.

Occurrence.—AQUIA FORMATION. Upper Marlboro.

Collection.—Maryland Geological Survey.

Genus TRUNCATULINA d'Orbigny.

TRUNCATULINA LOBATULA (Walker and Jacob).

Plate LXIV, Fig. 3.

Nautilus lobatulus Walker and Jacob, 1798, Adam's Essays (Kanmacher's Edit.), p. 642, pl. xiv, fig. 36.

Truncatulina lobatula Brady, 1884, Chal. Rept., vol. ix, p. 660, pl. xcii, fig. 10; pl. cxv, figs. 4, 5.

Truncatulina lobatula Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.

Truncatulina lobatula Bagg, 1898, Bull. Amer. Pal., No. 10, p. 35.

Description.—Test plano-convex, moderately vaulted; last volution consisting of seven, eight, or nine chambers with slightly depressed septa; septa more curved upon the superior (flat) surface; aperture a small, neatly-shaped arch at the margin of the ultimate segment. Diameter, 0.6 mm.

Truncatulina lobatula shows great variation. Professor Brady considers that the more convex varieties merge into *Truncatulina refulgens*,

while flattened forms resemble *Truncatulina wuellerstorfi*. The regular built convex varieties constitute *Truncatulina boueana* d'Orbigny and the less regular form the *Truncatulina variabilis* of the same author. *T. variabilis* is very well represented in the Miocene deposits at Plum Point, and elsewhere in the Atlantic Slope Miocene.

Truncatulina lobatula is probably the most widely distributed of all the Foraminifera. In present oceans it occurs in every latitude from the Arctic waters to the Antarctic Ice barrier. It is most frequent in shallow waters but is present also at depths of 3000 fathoms.

Its geological distribution begins with compact solid forms as far back as the Carboniferous and it is recorded in subsequent formations down to the present day.

Occurrence.—Nanjemoy Formation. Woodstock. Aquia Formation. Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Truncatulina ungeriana (d'Orbigny).

Plate LXIV, Fig. 4.

Rotalina ungeriana d'Orbigny, 1846, Foram. Fossiles Vienne, p. 157, pl. viii, figs. 16–18.

Truncatulina ungeriana Brady, 1884, Chal. Rept., vol. ix, p. 664, pl. xciv, fig. 9, *a–d*.

Description.—Test large, rotaliform, circular, coarsely porous, both sides moderately convex, unequal, depressed slightly on the inferior side at the umbilicus; consisting of three convolutions. The last volution composed of ten to twelve chambers. Septa arched; aperture a median slit of semilunar shape. Diameter, 0.78 mm.

This species is common in the Rancocas formation of the New Jersey Cretaceous and it is fairly abundant in the Lower Eocene of Upper Marlboro, near Seat Pleasant and elsewhere.

In the North Atlantic *Truncatulina ungeriana* is fairly abundant at from 90 to 600 fathoms, and while it has been found in the South Pacific at depths from 27 to 2600 fathoms it is nevertheless a shallow-water form. Specimens occur in the Lower Eocene of Pegwell Bay, England (Burrows) and in the London Clay, and it is recorded in the later Tertiaries of southern Europe.

Occurrence.—Aquia Formation. Upper Marlboro, Brooks Estate near Seat Pleasant, Well at Chesapeake Beach at 90-92 feet.

Collection.—Maryland Geological Survey.

Genus ANOMALINA d'Orbigny.

Anomalina ammonoides (Reuss).

Plate LXIV, Fig. 5.

Rosalina ammonoides Reuss, 1845–46, Verstein. böhm. Kreide, pt. i, p. 36, pl. viii, fig. 53; pl. xiii, fig. 66.

Anomalina ammonoides Brady, 1884, Chal. Rept., vol. ix, p. 672, pl. xciv, figs. 2, 3.

Anomalina ammonoides Bagg, 1898, Bull. 88, U. S. Geol. Survey, p. 67, pl. vi, fig. 5.

Description.—Test nautiloid, eoarsely porous, small, eompressed; lateral surface nearly equally convex; depressed at the umbiliei; peripheral edge round; aperture an arched nearly median opening upon the inner margin of the ultimate segment. Diameter, 0.5-0.8 mm.

In the North Atlantic off Bermuda good speeimens of *Anomalina ammonoides* were taken by the Challenger expedition but no other speeimens were found in the North Atlantic. These were at the depth of 435 fathoms. It was reeognized in dredgings in the South Pacifie at the depths of 210 fathoms (near the Fiji Islands), also at 1350 fathoms from the same vicinity, 275 fathoms off New Zealand, and another in Humboldt Bay at 37 fathoms. Parker and Jones obtained it from the Red Sea at depths of 372 and 678 fathoms, also in anehor muds near Hong Kong and shore sands at Melbourne. It is common as a fossil from Cretaceous time on through the Tertiaries.

Occurrence.—Aquia Formation. Upper Marlboro.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Anomalina grosserugosa (Gümbel).

Plate LXIV, Fig. 6.

Truncatulina grosserugosa Gümbel, 1868, Abhandl. d. k. bayer. Akad. Wiss., vol. x, p. 660, pl. ii, fig. 104, *a, b*.

Anomalina grosserugosa Brady, 1884, Chal. Rept., vol. ix, p. 673, pl. xciv, figs. 4, 5.

Anomalina grosserugosa Sherborn and Chapman, 1889, Jour. Royal Microsc. Soc., p. 487, pl. xi, fig. 24.

Anomalina grosserugosa Bagg, 1898, Bull. 88, U. S. Geol. Survey, p. 67, pl. vi, fig. 4.

Description.—Test nautiloid, very coarsely porous, pores larger and more numerous upon the inferior surface; both sides eonvex; umbilici

distinct; peripheral margin round; chambers large, inflated; only eight in final convolution; septa nearly straight; aperture median, arched. Diameter, 0.43-0.82 mm.

Though occurring in the Cretaceous the form is more frequently recorded in Tertiary deposits. Good recent specimens were secured by the Challenger in the North Atlantic at depths of 450 to 1000 fathoms, in the South Atlantic at 420 to 1415 fathoms, in the South Pacific at 610 and 2160 fathoms, and in the North Pacific at 325 and 2050 fathoms.

Occurrence.—AQUIA FORMATION. 1 mile northeast of Piscataway.

Collection.—Maryland Geological Survey.

Genus PULVINULINA Parker and Jones.

PULVINULINA EXIGUA VAR. OBTUSA Burrows.

Plate LXIV, Fig. 7.

Pulvinulina exigua var. obtusa Burrows, 1897, Proc. Geol. Assoc. (and reprint), vol. xv, pts. i, ii (March–May), p. 49, pl. ii, fig. 25 in reprint.

Description.—" Test free, rotaliform; both faces convex and generally equally so; composed of three convolutions, of which the outermost has usually five segments. Sutures non-limbate, marked on the superior face by thickened lines of opaque shell-substance; on the inferior by slight depressions; periphery obtuse, and very rarely lobulated." Burrows, 1897.

According to the above author *P. exigua* var. *obtusa* is next to *Bulimina elongata* the most common foraminifera of the Thanet Sands (Lower Eocene).

Our specimens agree closely with the figure of Burrows' varieties of *Pulvinulina exigua* as figured by Professor Brady, but there are six instead of five chambers in the final convolution and the form is not quite so obtuse as the type forms. The perfectly straight septa so obliquely set upon the superior surface are more distinct in the outer convolution. Upon the inferior side these run straight to the center of the umbilicus. The type of the species (*P. exigua*) is regarded as a deep water form. In the Challenger expedition it was obtained at depths ranging

from 64 to 2740 fathoms but it is quite possible that this variety of the form is not to be so regarded.

Occurrence.—Aquia Formation. 1 mile northeast of Piscataway.

Collection.—Maryland Geological Survey.

Pulvinulina schreibersii (d'Orbigny).

Plate LXIV, Fig. 8.

Rotalina schreibersii d'Orbigny, 1846, Foram. Fossiles Vienne, p. 154, pl. vii, figs. 4–6.

Pulvinulina schreibersii Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.

Pulvinulina schreibersii Bagg, 1898, Bull. Amer. Pal., No. 10, p. 37, pl. xxiii, fig. 2.

Description.—Test orbicular, superior side more convex than inferior; consisting of about seven chambers in the final convolution (some specimens show nine); inferior side distinctly stellate with depressed septal lines and elevated chambers, the latter feature being characteristic for the species and distinguishing it from *Pulvinulina karsteni,* by lack of peripheral keel. The final chamber is larger and more globose than the one adjoining; umbilicus depressed on the inferior side; aperture a submarginal slit; diameter, 0.4-0.54 mm.

This species is not uncommon in the Eocene of Woodstock but seems to be quite rare in the Miocene of James River, Va.

Referring to the depth at which this species is found in present oceans Professor Brady says in the Challenger Report—"off New Hebrides 125 fathoms; off Ki Islands, 129 fathoms; southwest of Papua, 28 fathoms; off Raine Island, 155 fathoms; off Cape York, Torres Strait, 3-11 fathoms; Humboldt Bay, Papua, 37 fathoms; and off Admiralty Islands, 17 fathoms; . . . off Bermuda, 435 fathoms. Parker and Jones record its occurrence in the Red Sea, 40 fathoms, and in the Mediterranean, 90 fathoms."

Occurrence.—Nanjemoy Formation. Woodstock, Well at Chesapeake Beach at 90-92 feet.

Collections.—Johns Hopkins University, Maryland Geological Survey.

Genus NONIONINA d'Orbigny.

Nonionina affinis Reuss.

Plate LXIV, Fig. 9.

Nonionina affinis Reuss, 1851, Sitzungsb. d. k. Akad. Wiss. Wien, vol. iii, p. 72, pl. v, fig. 32.
Nonionina affinis Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.
Nonionina affinis Bagg, 1898, Bull. Amer. Pal., No. 10, p. 39, pl. i, fig. 5.

Description.—Test small, orbicular, strongly compressed, umbilicate, finely perforate; chambers ten to twelve, small, flat, slightly curved, separated by fairly distinct band-like septal lines; septal plane of ultimate chamber somewhat higher than broad and quite large; aperture short, semilunar. Diameter, 0.32 mm. Professor Reuss' figure agrees fairly well with our specimens but there are twelve chambers visible in the last volution. According to Reuss this species is closely related to *Nonionina punctata* d'Orbigny, but the latter is thicker in transverse section.

Occurrence.—Nanjemoy Formation. Woodstock.

Collection.—Johns Hopkins University.

Genus AMPHISTEGINA d'Orbigny.

Amphistegina lessonii d'Orbigny.

Plate LXIV, Fig. 10.

Amphistegina lessonii d'Orbigny, 1826, (parte) Ann. Sci. Nat., vol. vii, p. 304, No. 3, pl. xvii, figs. 1-4.
Amphistegina lessonii Brady, 1884, Chal. Rept., vol. ix, p. 740, pl. cxii, figs. 1-7.
Amphistegina lessonii Bagg, 1896, Bull. 141, U. S. Geol. Survey, p. 92.
Amphistegina lessonii Bagg, 1898, Bull. Amer. Pal., No. 10, p. 42, pl. i, fig. 6.

Description.—Test circular, compressed, transverse elliptical; superior only slightly more elevated than the inferior; superior surface shows about eighteen angular segments; inferior surface less distinctly chambered, more irregular; chambers narrow, angular, visible in transmitted light; surface smooth and of a brownish-yellow color. Diameter, 1.47-2 mm.

Professor Brady states that this species shows great variation in the amount of convexity. Our specimens agree more closely with his Fig. 4

of Plate CVI, in the Challenger Report and may be considered as typical for the species. This is not a common form and only three specimens have been obtained at Woodstock and only a few are found in the Miocene of Darlington, S. C., nearly all of which are imperfect specimens.

In existing oceans this form is commonest on bottoms of less than 30 fathoms depth and is rare below 300 to 400 fathoms. It is more frequent in warm tropical waters. As a fossil it has been variously described from the Tertiaries of Europe, among them being the Eocene of the Paris Basin (Terquem), Upper Eocene of the Swiss Alps (Kaufmann), etc.

Occurrence.—NANJEMOY FORMATION. Woodstock.

Collection.—Johns Hopkins University.

PLANTAE.

CARPOLITHUS MARYLANDICUS n. sp.

Plate LXIV, Figs. 11, 11a, 11b.

Fruit irregularly ovate, about $\frac{3}{4}$ inch long, broadest at the base, 4-valved (?); valves separating completely to the base; epicarp rough, somewhat warty, wrinkled or ridged longitudinally, about 1-16 inch thick, distinct from the smooth pericarp; seed cells about $\frac{3}{8}$ inch long by $\frac{1}{8}$ inch broad, attenuate towards the apex of the fruit and rounded at the base.

CARPOLITHUS MARYLANDICUS VAR. RUGOSUS n. var.

Plate LXIV, Figs. 12, 12a, 12b.

Orbicular, about 7-16 inch in diameter, or less; warty, but without longitudinal markings; seed cells relatively broader to the length than in the species.

The material upon which the descriptions and figures of Carpolithus are founded is exceedingly fragmentary, not one entire fruit being represented in the collection. The drawings of the complete fruits were made by fitting together disconnected valves, and as these vary in size

the number of valves into which the fruit was actually divided is uncertain. They may have been three or four or five, and for that reason the number is questioned in the description.

The fruit resembles quite closely *Phymatocoryon mackayi* Muell., from the auriferous drifts of Australia, described in the Report of the Geological Survey of Victoria for 1874, p. 11, pl. ii, which is however definitely 3-valved. The geological horizon of these drifts is considered as Pliocene.

In this connection it may be of interest to note that the fossil fruit deposit of Brandon, Vt., described by Hitchcock (Commonwealth of Massachusetts, House Document No. 39, 1853, pp. 22-34; Amer. Jour. Sci., vol. xv, 1853, pp. 95-104) and by Lesquereux (Rept. Geology of Vermont, vol. ii, 1861, pp. 712-718; Amer. Jour. Sci., vol. xxxii, 1861, pp. 355-363) has been called by different authorities Eocene, Miocene, Pleiocene and Pleistocene.

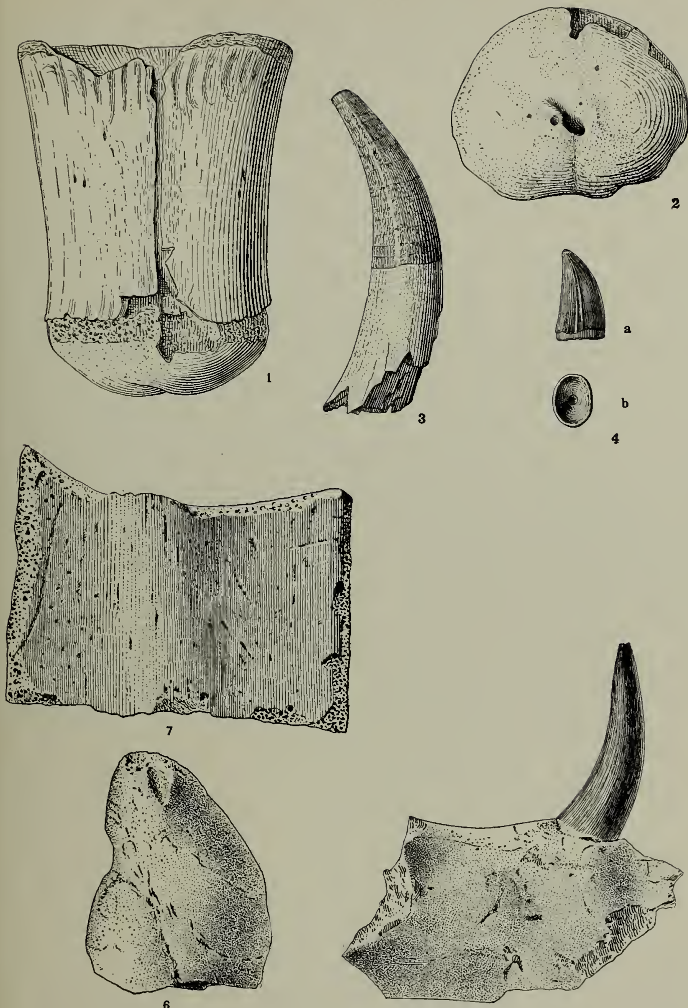
The general appearance of our material is quite similar to that from Brandon, being thoroughly lignitized, with the general form of the fruit preserved. The internal structure has, however, been more or less destroyed or altered and it has, therefore, not been possible to determine satisfactorily the probable botanical affinities.

The only other record with which I am familiar, of similar material from the United States, is by Edmund Ruffin (Amer. Jour. Sci., ser. ii, vol. ix, 1850, pp. 127-129) describing a fossil nut from the Eocene marl of Marlbourne, Va.

None of the American species described or figured may be satisfactorily identified with our specimens.

PLATES

PLATE X.



REPTILIA.

PLATE XI.

1

2

REPTILIA.

PLATE XII.

PAGE

Figs. 1. 2. MYLIOBATIS COPEANUS Clark 99

1. Oral aspect of upper dental plate of an adult individual. The anterior end is uppermost. Clifton Beach.
2. Portion of lower dental plate of an immature individual, showing two rows of lateral teeth and anterior depression due to wear. Clifton Beach.

Fig. 3. MYLIOBATIS MAGISTER Leidy 100

Oral aspect of a very large upper dental plate, the anterior end shown uppermost in the figure. Museum Comp. Zool., Cambridge. Ashley River, S. C.

Figs. 4-6. OTOLITES of Teleostome Fishes.............................. 113

Popes Creek. × 4.

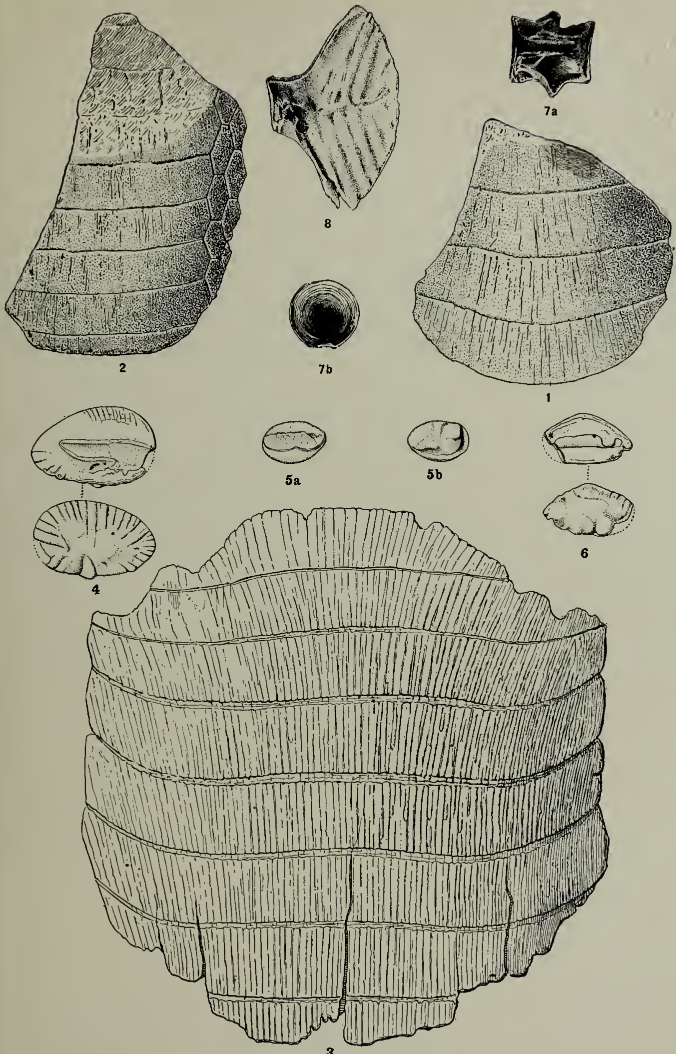
Figs. 7a, 7b. Detached vertebral centrum of an indeterminate Teleostome fish 110

7a. Lateral view. Clifton Beach.

7b. End view of same specimen.

Fig. 8. XIPHIAS (?) RADIATA (Clark) 112

Hypural fan as viewed from the left lateral aspect. Clifton Beach.



PISCES.

PLATE XIII.

PAGE

Figs. 1a, 1b. MYLIOBATIS MAGISTER Leidy 100

1a. Transverse surface of the same specimen shown in Plate XII, Fig. 3. The anterior end is placed uppermost in the figure.

1b. Attached surface of same specimen.

Figs. 2a, 2b. MYLIOBATIS COPEANUS Clark 99

2a. Transverse section. Liverpool Point.

2b. Attached surface, same locality. The anterior end is placed uppermost in the figures.

Figs. 3a, 3b. AETOBATIS ARCUATUS Agassiz 102

3a. Attached surface of detached tooth. Popes Creek.

3b. Lateral aspect of same specimen.

Fig. 4. MYLIOBATIS sp. 101

Transverse and longitudinal views of caudal spine, Ashley River, S. C. Museum Comp. Zool., Cambridge.

Fig. 5. MYLIOBATIS sp. 101

Transverse and longitudinal views of caudal spine, Montgomery, La. Museum Comp. Zool., Cambridge.

Figs. 6, 7a, 7b. MYLIOBATIS COPEANUS Clark 99

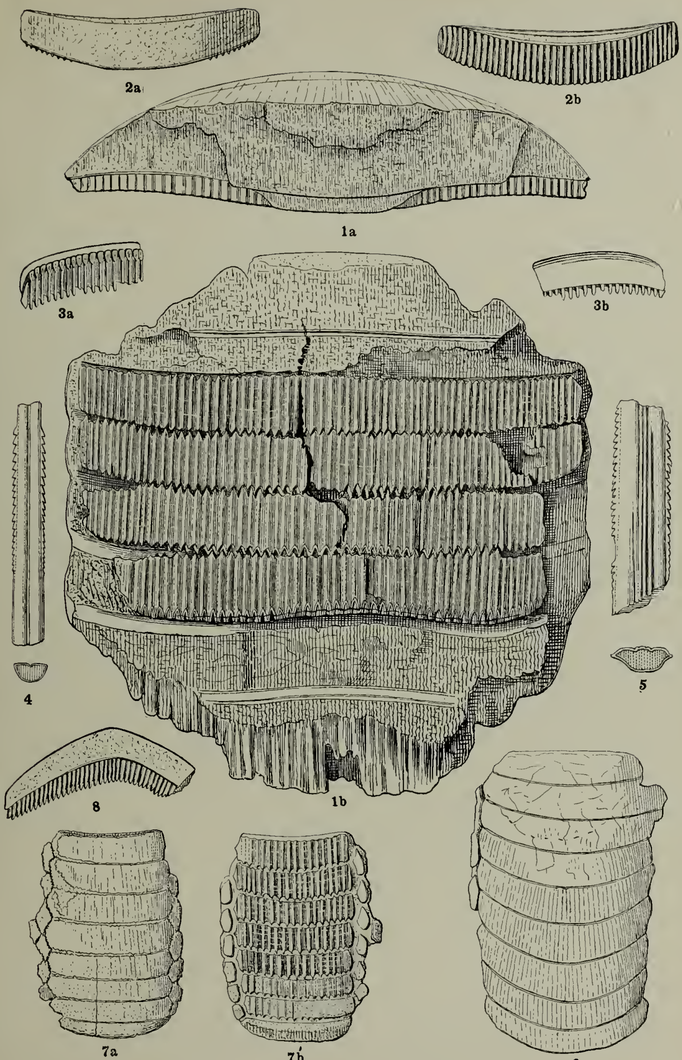
6. Nearly perfect upper dental plate of a comparatively young individual; the anterior end shown uppermost in the figure. Clifton Beach.

7a. Oral surface of lower dental plate of a comparatively young individual with serrated sutures due to wear. Clifton Beach.

7b. Inferior aspect of same specimen.

Fig. 8. AETOBATIS ARCUATUS Agassiz 102

Oral surface of a detached tooth. Popes Creek.



PISCES.

PLATE XIV.

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Figs. 1a, 1b. Odontaspis cuspidata (Agassiz) 105

1a. Inner face of a tooth with well-developed lateral denticles. Liverpool Point.

1b. Outer face of same specimen.

Figs. 2a, 2b, 2c, 3a, 3b, 3c. Odontaspis elegans (Agassiz).............. 104

2a. Inner face of a worn anterior tooth lacking its pair of lateral denticles. Liverpool Point.

2b. Lateral aspect of the same specimen.

2c. Outer face of the same specimen.

3a. Inner face of a well-preserved tooth showing prominent coronal striae. Aquia Creek.

3b. Lateral aspect of the same specimen.

3c. Outer face of the same specimen.

Figs. 4a, 4b. Odontaspis macrota (Agassiz) 105

4a. Outer face of a tooth. Liverpool Point.

4b. Inner face of the same specimen.

Figs. 5a, 5b, 5c. Synechodus clarkii n. sp............................. 103

5a. Inner face of a tooth. Liverpool Point.

5b. Lateral aspect of the same specimen.

5c. Outer face of the same specimen.

Figs. 6a, 6b. Odontaspis cuspidata (Agassiz) 105

6a. Outer face of a tooth. Liverpool Point.

6b. Inner face of the same specimen.

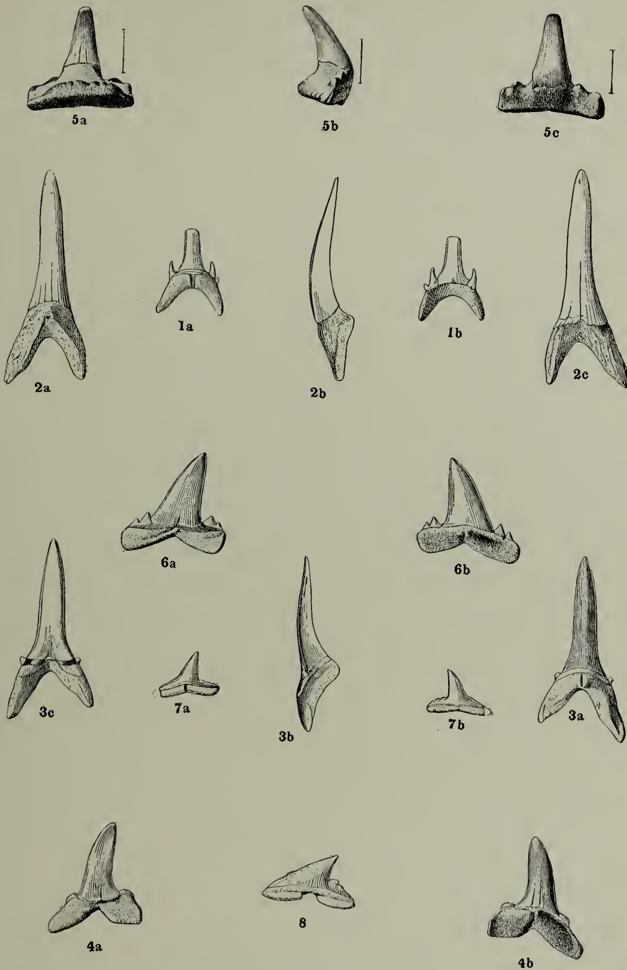
Figs. 7a, 7b. Sphyrna prisca Agassiz 110

7a. Inner face of a tooth. Liverpool Point.

7b. Outer face of the same specimen.

Fig. 8. Galeocerdo latidens Agassiz 109

Outer face of a tooth. Woodstock. × 2



PISCES.

PLATE XV.

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Figs. 1-4. OTODUS OBLIQUUS Agassiz.................................... 106

1a. Inner face of an anterior tooth belonging to an immature individual, and corresponding in size to the lateral tooth shown in Fig. 5. Liverpool Point.

1b. Lateral aspect of same specimen.

1c. Outer face of same specimen.

2a. Inner face of a lateral tooth belonging to an immature individual. Liverpool Point.

2b. Lateral aspect of same specimen.

2c. Outer face of same specimen.

3a. Outer face of a lateral tooth, with a well-developed pair of lateral denticles. Aquia Creek.

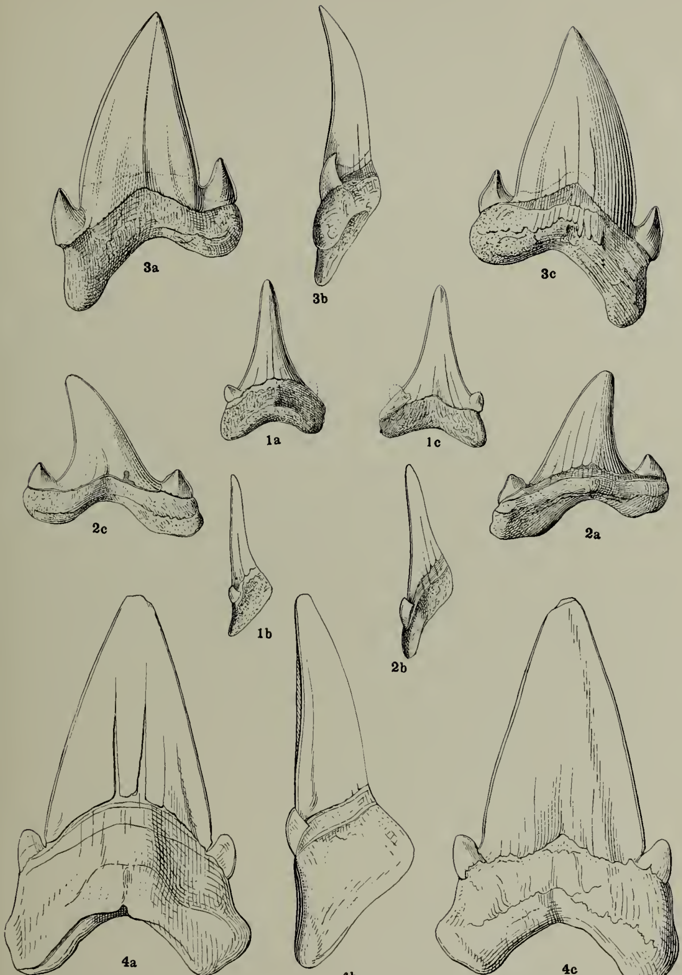
3b. Lateral aspect of same specimen.

3c. Inner face of same specimen.

4a. Inner face of an unusually large and massive tooth with erect crown, entire edges and large lateral denticles, showing transitional characters between *Carcharodon* and *Lamna*. Glymont.

4b. Lateral aspect of same specimen.

4c. Outer face of same specimen.



PISCES.

PLATE XVI.

PAGE

Figs. 1-4. BYTHOCYPRIS SUBAEQUATA n. sp. 116
1. Right side of an entire carapace. Upper Marlboro.
2. Dorsal view of same.
3. Anterior view of same.
4. Inner side left valve showing internal marginal plate.

Figs. 5-8. BYTHOCYPRIS PARILIS n. sp. 117
5. Right side of entire carapace. Upper Marlboro.
6. Ventral edge of same.
7. Inner side of right valve.
8. Inner side of left valve.

Figs. 9-13. CYTHERELLA MARLBOROENSIS n. sp. 117
9. Left side of a perfect carapace. Upper Marlboro.
10. Right side of another specimen from same locality.
11. Dorsal view in outline of same.
12. Inner side of a right valve.
13. Anterior end view.

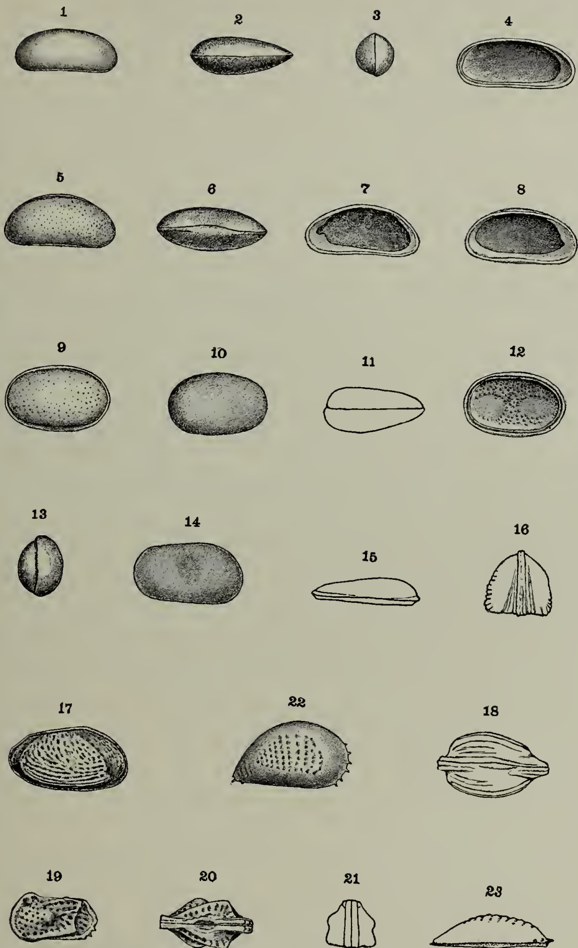
Figs. 14-15. CYTHERELLA SUBMARGINATA n. sp. 118
14. A left valve showing slight mesial depression and marginal rim. Upper Marlboro.
15. Ventral view of same.

Figs. 16-18. CYTHERE MARYLANDICA n. sp. 119
16. Posterior end view of an entire carapace. Upper Marlboro.
17. Right side of same.
18. View of ventral edge of same.

Figs. 19-21. CYTHEREIS BASSLERI n. sp. 120
19. An average left valve of this species.
20. Ventral edge of an entire carapace.
21. Outline view of anterior end of same.

Figs. 22-23. CYTHERIDEA PERARCUATA n. sp. 121
22. View of a right valve.
23. Ventral edge of same.

All the figures are magnified 20 diameters.



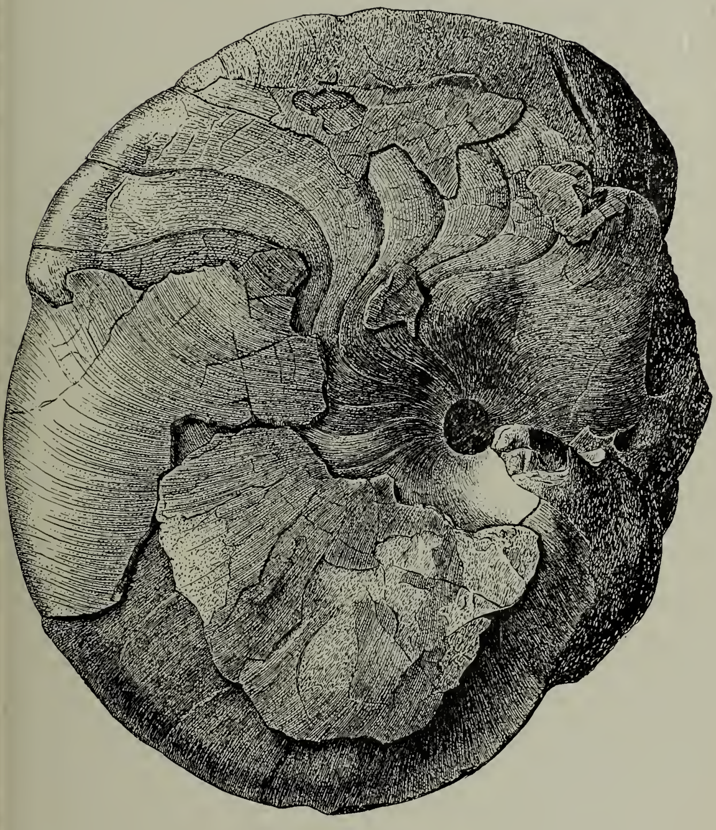
ARTHROPODA—CRUSTACEA.

PLATE XVII.

b

MOLLUSCA—CEPHALOPODA.

PLATE XVIII.



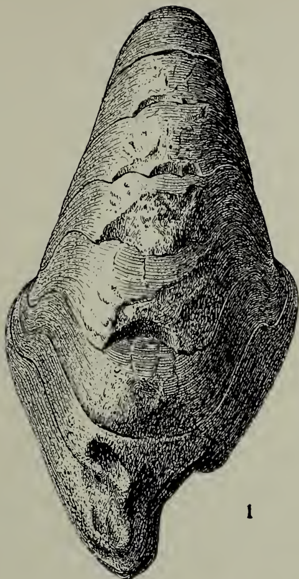
MOLLUSCA—CEPHALOPODA.

PLATE XIX.

PAGE

Figs. 1-3. Hercoglossa tuomeyi n. sp. 122

1. Peripheral view of specimen illustrated on Plate XVII. Popes Creek. × ⅔
2. Specimen showing fragment of shell substance from near periphery. Popes Creek. × ⅔
3. Specimen showing a fragment of shell from near the umbilicus. Clifton Beach.



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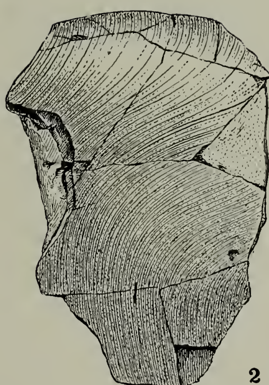

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MOLLUSCA—CEPHALOPODA.

PLATE XX.

PAGE

Figs. 1, 1a, 2. TORNATELLAEA BELLA Conrad 123
1. Aquia Creek. U. S. National Museum.
1a. Dorsal view of same specimen.
2. Aquia Creek. Acad. Nat. Sci. Phila. Lea Memorial Coll.

Fig. 3, 3a. RINGICULA DALLI Clark 124
3. Dorsal view. (After Clark.) Woodstock.
3a. Ventral view of same specimen. (After Aldrich.)

Figs. 4, 4a. CYLICHNA VENUSTA Clark 124
4. Ventral view of type specimen. Woodstock.
4a. Dorsal view of same specimen.

Figs. 5, 5a, 6. PLEUROTOMA HARRISI Clark 125
5, 5a. Original figures of type specimen. Potomac Creek.
6. Specimen with more distinct sculpture. Same locality.

Figs. 7, 7a. PLEUROTOMA POTOMACENSIS n. sp. 126
7. Ventral view of type specimen. 2 miles below Potomac Creek.
7a. Dorsal view of type specimen.

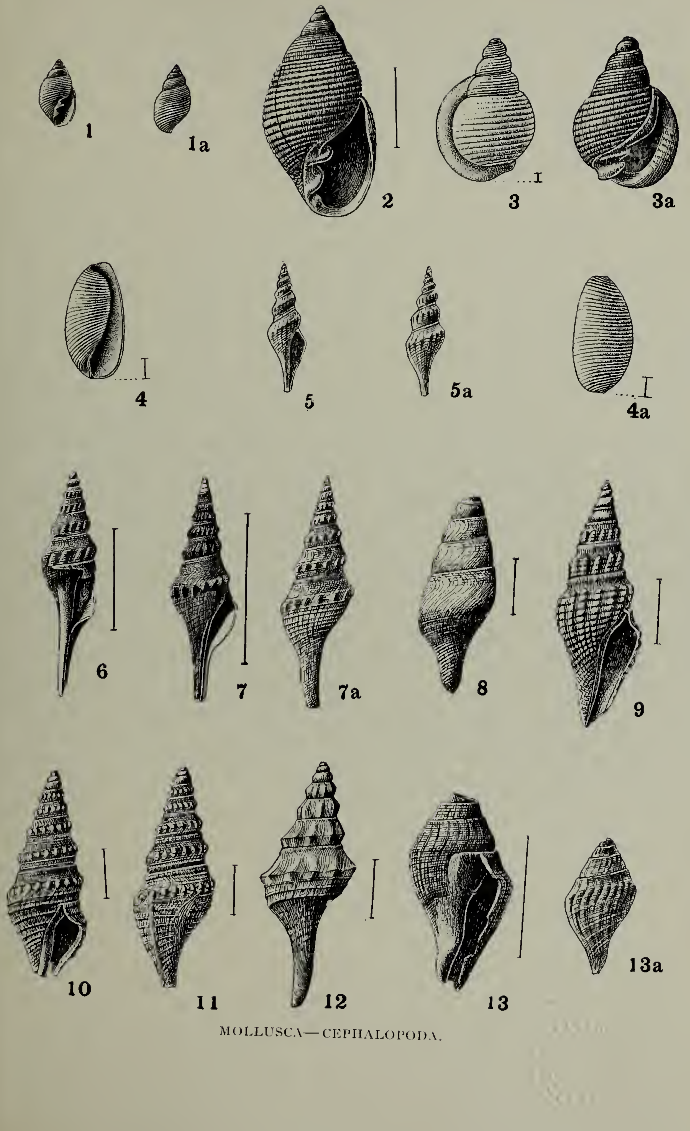
Fig. 8. PLEUROTOMA DUCATELI n. sp. 126
Dorsal view of type specimen. 1 mile southeast of Mason Springs.

Fig. 9. PLEUROTOMA TYSONI n. sp. 126
Ventral view of type specimen. 1 mile southeast of Mason Springs.

Figs. 10, 11. PLEUROTOMA CHILDRENI Lea 127
10. Ventral view of broken specimen. 1 mile southeast of Mason Springs.
11. Dorsal view of more nearly perfect individual.

Fig. 12. PLEUROTOMA PISCATAVENSIS n. sp. 127
Dorsal view of type specimen. 1 mile northeast of Piscataway.

Figs. 13, 13a. MANGILIA (PLEUROTOMELLA) BELLISTRIATA Clark......... 128
13. Ventral view of type specimen, enlarged as indicated. Popes Creek.
13a. Dorsal view of same specimen, natural size.



MOLLUSCA—CEPHALOPODA.

PLATE XXI.

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Fig. 1. Cancellaria graciloides Aldrich var. 128
Ventral view of specimen from 1 mile southeast of Mason Springs.

Fig. 2. Cancellaria sp. 129
Much enlarged view of specimen from 2 miles below Potomac Creek.

Figs. 3, 3a. Cancellaria (Narona) potomacensis n. sp. 129
3. Ventral view of specimen from 1 mile northeast of Piscataway.
3a. Dorsal view of same specimen.

Figs. 4, 5, 5a. Volutilithes petrosus (Conrad) 130
4. Pomonkey Neck. U. S. National Museum.
5. Dorsal view. Potomac Creek.
5a. Ventral view of same specimen.

Figs. 6, 6a. Volutilithes sp. 131
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6a. Dorsal view of same specimen.

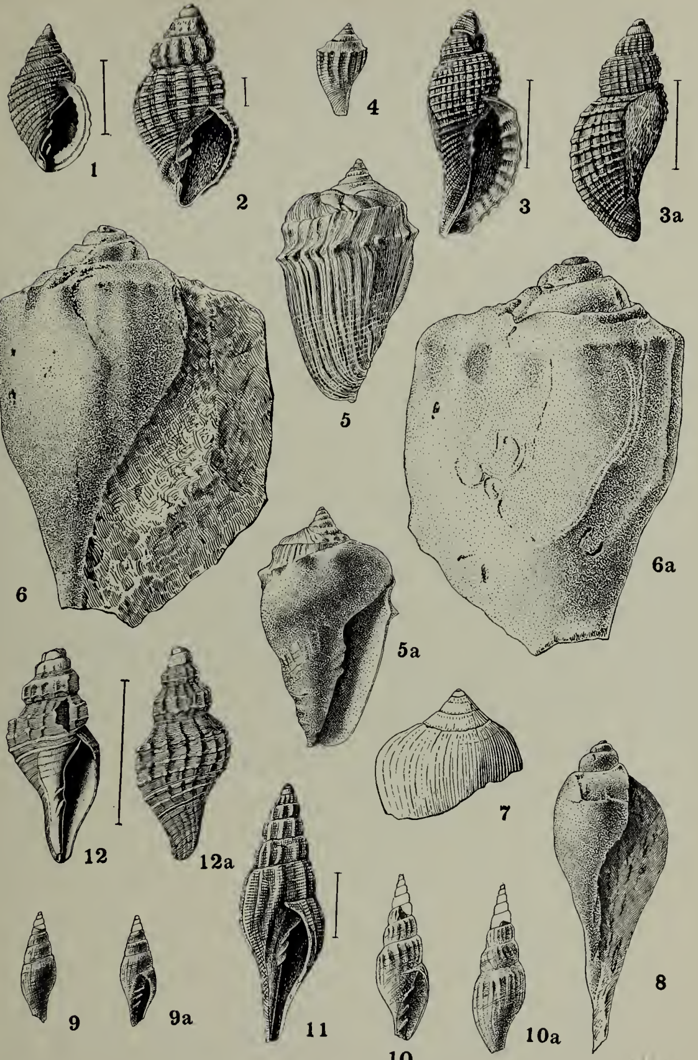
Figs. 7, 8. Caricella pyruloides (?) (Conrad) 131
7. Spire and part of body whorl. Potomac Creek.
8. Cast. Aquia Creek.

Figs. 9, 9a. Mitra marylandica Clark 132
9. Dorsal view. Pomonkey Neck. U. S. National Museum.
9a. Ventral view of same specimen.

Figs. 10, 10a. Mitra pomonkensis n. sp. 132
10. Ventral view. Pomonkey Neck. U. S. National Museum.
10a. Dorsal view of same specimen.

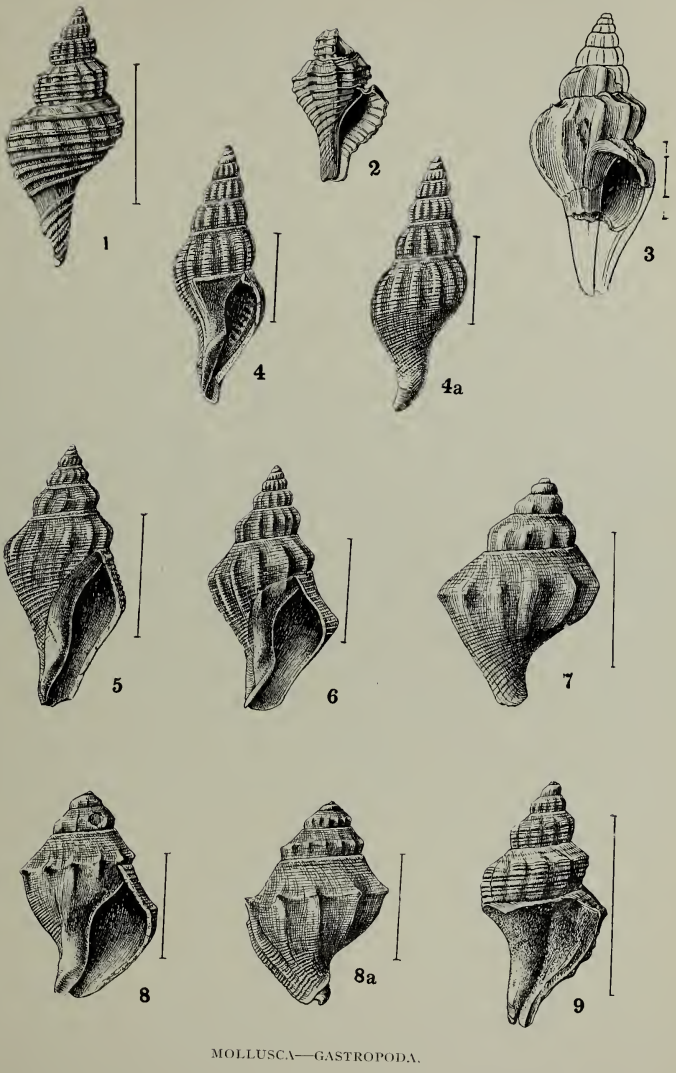
Fig. 11. Mitra potomacensis n. sp. 133
Enlarged view. 1 mile northeast of Piscataway.

Figs. 12, 12a. Latirus marylandicus n. sp. 133
12. Ventral view. 2 miles below Potomac Creek.
12a. Dorsal view of same specimen.



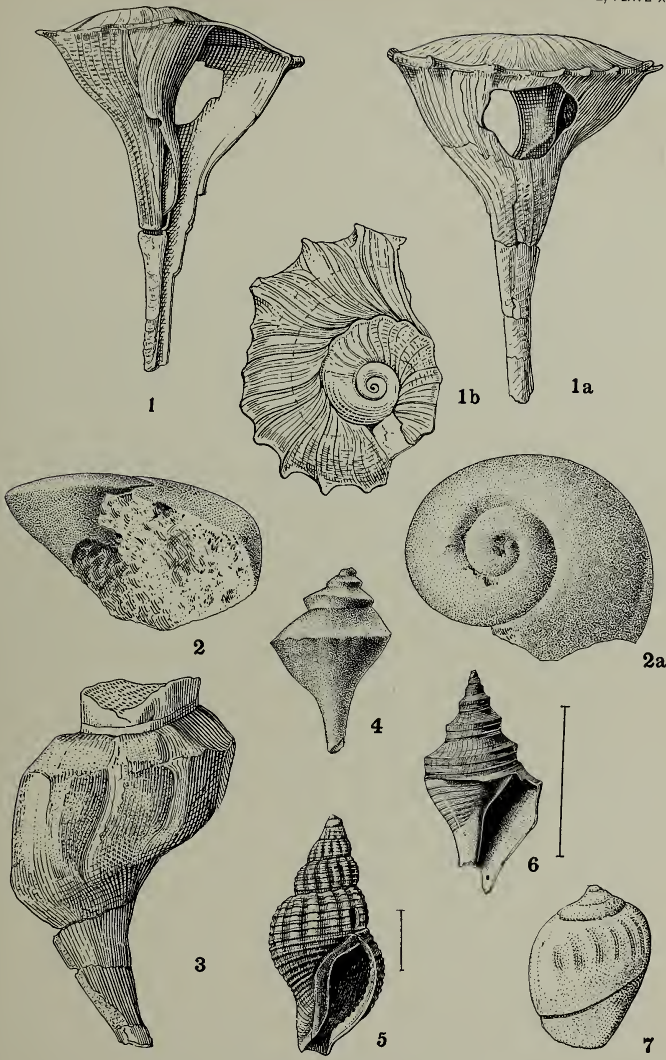
MOLLUSCA—GASTROPODA.

PLATE XXII.



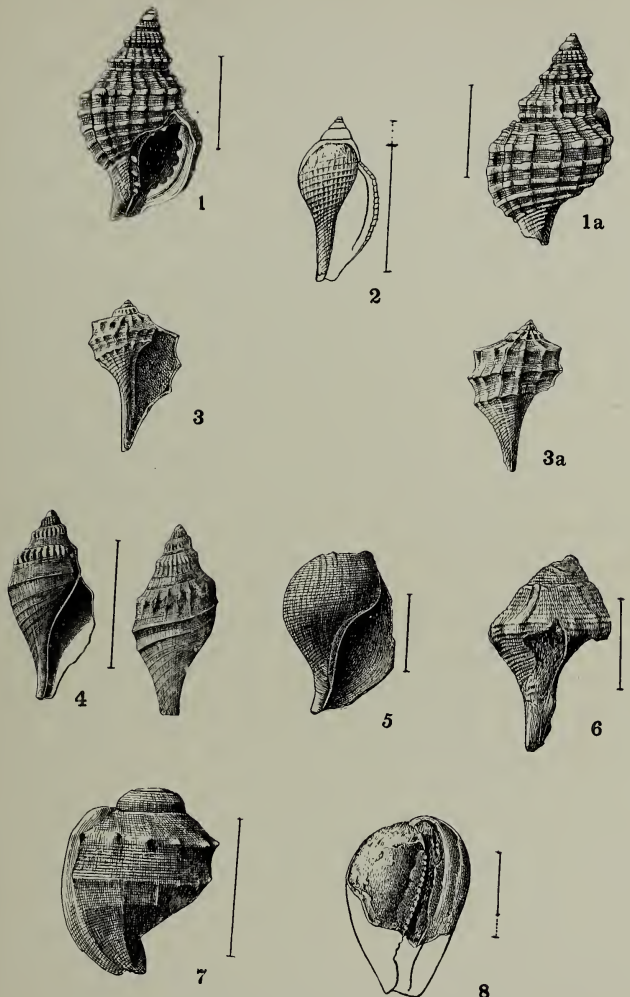
MOLLUSCA—GASTROPODA.

PLATE XXIII.



MOLLUSCA—GASTROPODA.

PLATE XXIV.



MOLLUSCA—GASTROPODA.

PLATE XXV.

PAGE

Figs. 1, 1a, 2. CALYPTRAPHORUS JACKSONI Clark 145

1. Dorsal view of type. Sheckels Farm near South River.

1a. Ventral view of same specimen.

(Figs. 1 and 1a are modified and corrected copies of the original figures in Bull. 141, U. S. Geol. Survey.)

2. Dorsal view of large individual from same locality.

Fig. 3. CALYPTRAPHORUS TRINODIFERUS Conrad 145

Dorsal view. 2 miles below Potomac Creek.

Figs. 4, 4a. CALYPTRAPHORUS TRINODIFERUS (?) Conrad var............. 146

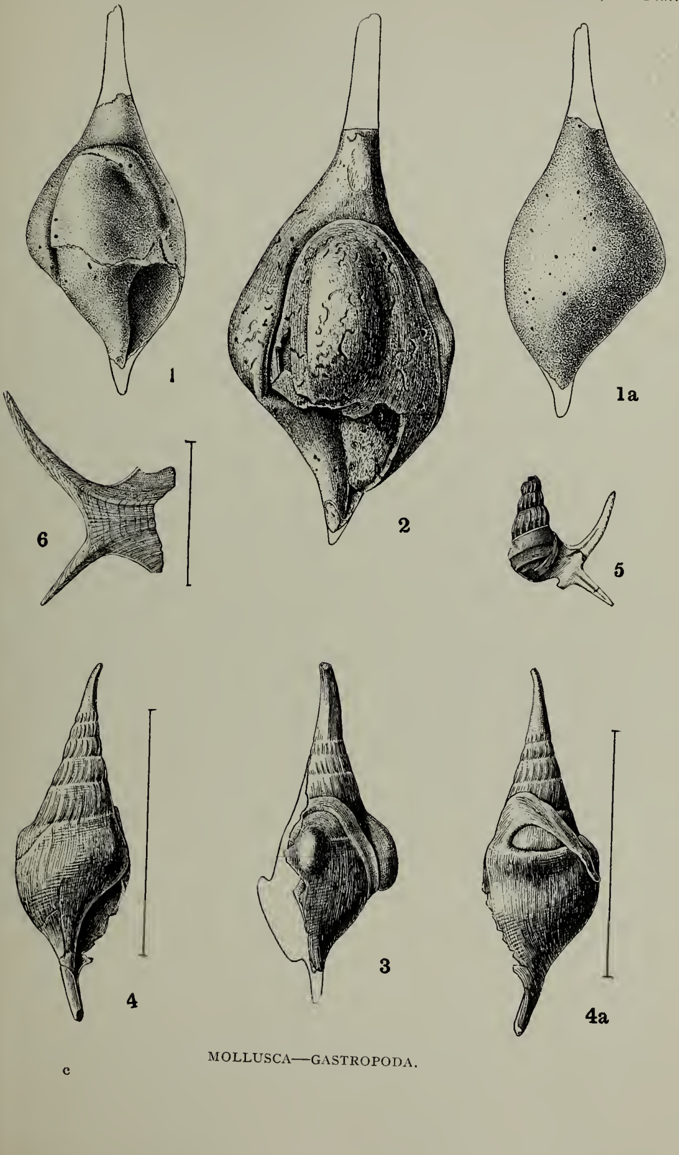
4. Ventral view. 1 mile southeast of Mason Springs.

4a. Dorsal view of the same specimen.

Figs. 5, 6. APORRHAIS POTOMACENSIS n. sp. 146

5. Ventral view of imperfect individual. Digitations restored from original of Fig. 6. 1 mile northeast of Piscataway.

6. External view of labrum of large individual from same locality.



MOLLUSCA—GASTROPODA.

PLATE XXVI.

PAGE

Figs. 1-5. TURRITELLA MORTONI Conrad 147

1. Ventral view of specimen. Potomac Creek.

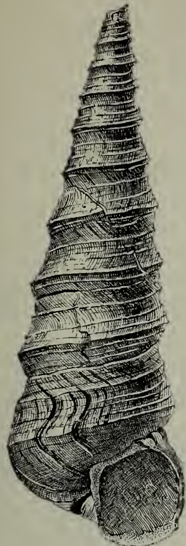
1a. Dorsal view of same specimen.

2. More elongate specimen from same locality.

3. Specimen from same locality with stronger basal carina.

4. Internal cast.

5. Specimen showing the strong basal carina of the variety *postmortoni* of Harris. Tinkers Creek.



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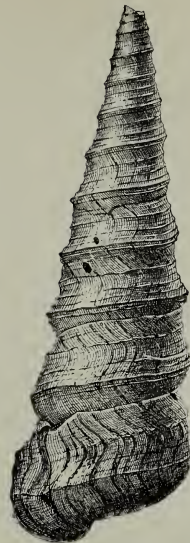

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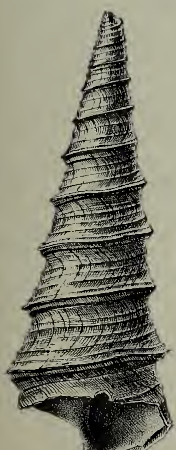

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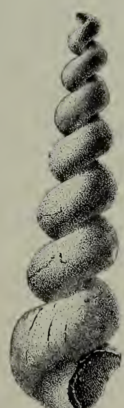

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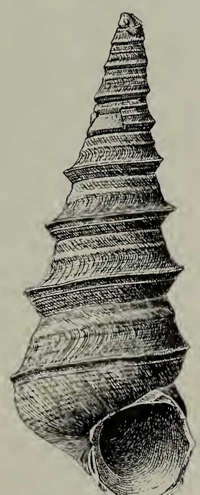

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MOLLUSCA—GASTROPODA.

PLATE XXVII.

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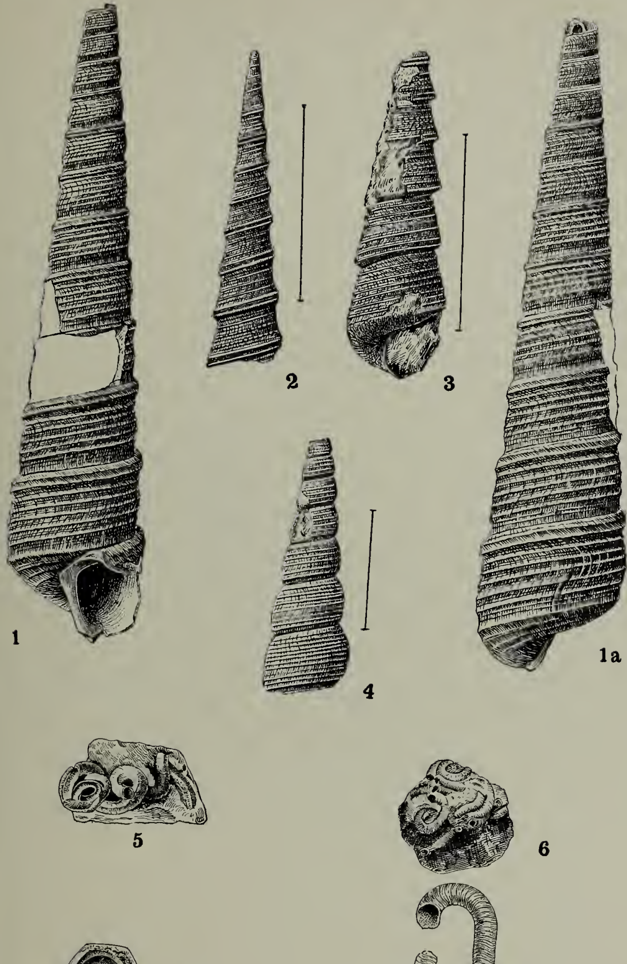
1. Ventral view. 1 mile southeast of Mason Springs.	
Figs. 2, 3. TURRITELLA POTOMACENSIS n. sp.	149
Type specimens. Popes Creek.	
Fig. 4. MESALIA OBRUTA (Conrad)	149
Popes Creek.	
Figs. 5, 5a, 6, 7. VERMETUS sp.	150
5. Small mass of tubes.	
5a. End of same tube, enlarged.	
6. Mass of tubes. Piscataway Creek. U. S. National Museum.	
7. Short fragment of tube from same specimen, enlarged.	



MOLLUSCA—GASTROPODA.

PLATE XXVIII.

PAGE

Fig. 1. NATICA CLIFTONENSIS Clark 150
Ventral view of type specimen. Clifton Beach.

Figs. 2, 2a, 3. LUNATIA MARYLANDICA Conrad 151

Figs. 4, 5. CALYPTRAEA APERTA (Solander) 152
4. Dorsal view of specimen. 1 mile southeast of Mason Springs.
5. Cast of large individual.

Figs. 6, 6a. LITIOPA MARYLANDICA n. sp. 152
6. Dorsal view of type specimen. 2 miles below Potomac Creek.

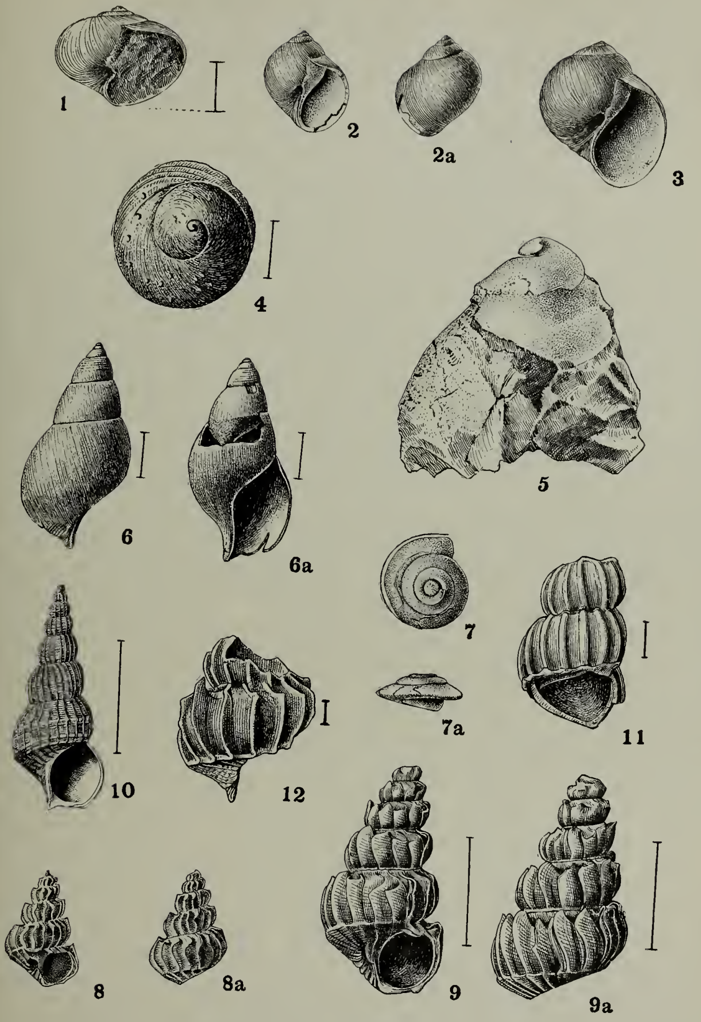
Figs. 7, 7a. SOLARIUM sp. 153
7. Cast, as seen from above. Aquia Creek.
7a. Same specimen as seen from the side.

Figs. 8, 8a, 9, 9a. SCALA VIRGINIANA Clark 153
8. Ventral view of type specimen. Aquia Creek. U. S. National Museum.
8a. Dorsal view of same specimen.
9. Ventral view of specimen. Potomac Creek. Acad. Nat. Sci. Phila.
9a. Dorsal view of the same specimen.

Fig. 10. SCALA POTOMACENSIS n. sp. 154
Type specimen. 2 miles below Potomac Creek.

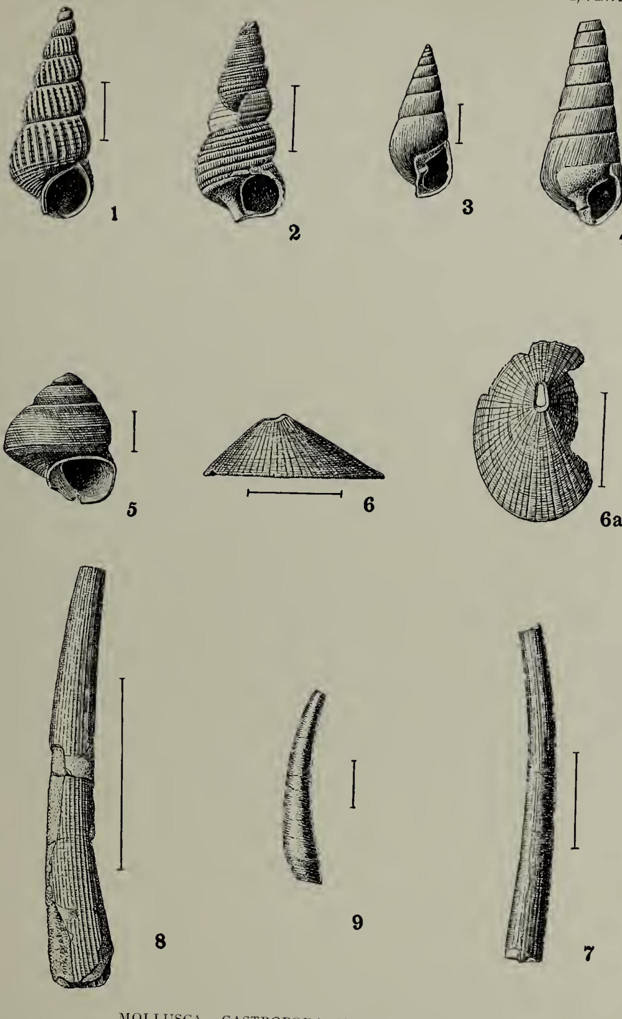
Fig. 11. SCALA SESSILIS Conrad 154
2 miles below Potomac Creek.

Fig. 12. SCALA CARINATA Lea 154
2 miles below Potomac Creek.



MOLLUSCA—GASTROPODA.

PLATE XXIX.



MOLLUSCA—GASTROPODA AND SCAPHOPODA.

PLATE XXX.

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Figs. 1, 1a. TEREDO VIRGINIANA (?) Clark 160

1. Lateral view enlarged as indicated.

1a. End view of same specimen.

Figs. 2, 2a, 3. TEREDO VIRGINIANA Clark 160

2. Lateral view of small fragment of tube. Woodstock.

2a. End view of same specimen.

3. Lateral view of another fragment. Woodstock.

Figs. 4, 4a, 4b. PHENACOMYA PETROSA (Conrad) 161

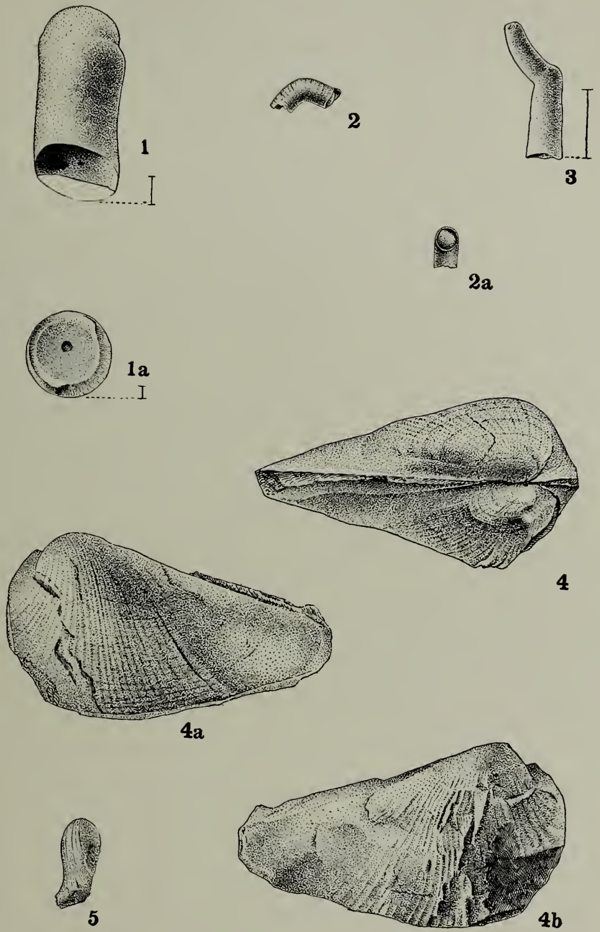
4. Dorsal view of cast. Fort Washington.

4a. Same specimen as seen from the left.

4b. Same specimen as seen from the right.

Fig. 5. GASTROCHAENA sp. 161

Cast of tube. Aquia Creek.



MOLLUSCA—PELECYPODA.

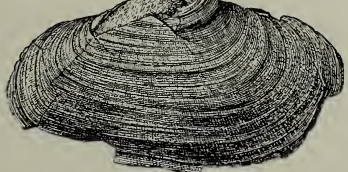
PLATE XXXI.

1. Left aspect of cast. Fort Washington.
2. Left valve. Aquia Creek.

2a. Surface of same specimen. × 17

3. Right valve of Fig. 1.
4. Left valve. Fort Washington.
5. Right valve. Fort Washington.

1



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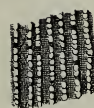
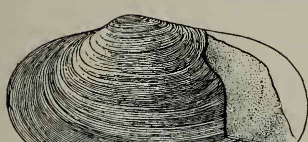


2a

3



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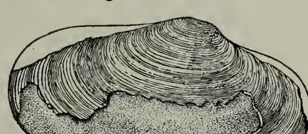

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MOLLUSCA—PELECYPODA.

PLATE XXXII.

	PAGE
Figs. 1, 1a, 2, 2a, 2b. CORBULA SUBENGONATA Dall	163

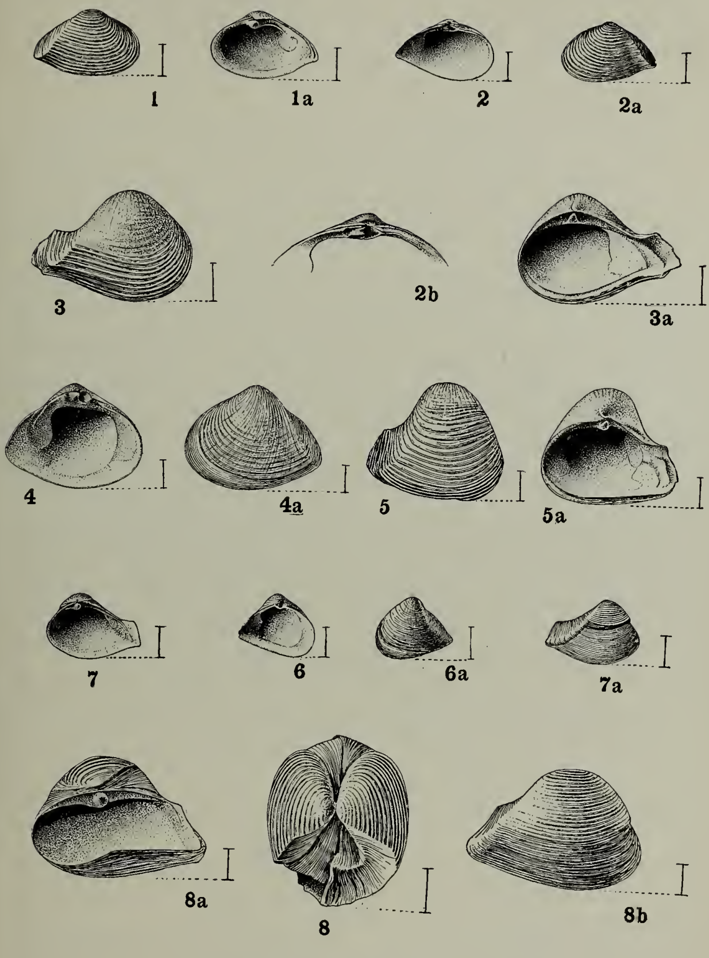
1. Exterior of right valve. Popes Creek.
1a. Interior of same specimen.
2. Interior of left valve. Popes Creek.
2a. Exterior of same specimen.
2b. Hinge of same specimen, enlarged.

Figs. 3, 3a, 4, 4a, 5, 5a, 6, 6a. CORBULA ALDRICHI Meyer	163

3. Exterior of right valve. Evergreen, Va.
3a. Interior of same specimen.
4. Interior of left valve. Evergreen, Va.
4a. Exterior of same specimen.
5. Exterior of right valve. Evergreen, Va.
5a. Interior of same specimen.
6. Interior of young left valve. Evergreen, Va.
6a. Exterior of same specimen.

Figs. 7, 7a, 8, 8a, 8b. CORBULA ONISCUS Conrad	164

7. Interior of right valve. Evergreen, Va.
7a. Exterior of same specimen.
8. Dorsal view of specimen. Evergreen, Va.
8a. Interior of right valve of same individual.
8b. Exterior of same valve.



MOLLUSCA—PELECYPODA.

PLATE XXXIII.

PAGE

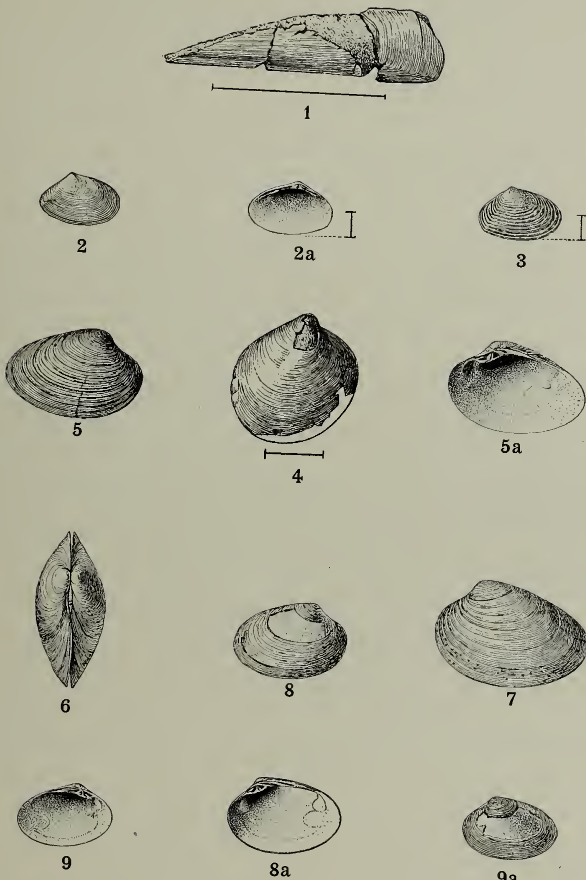
Fig. 1. SOLEN LISBONENSIS (?) Aldrich 165
Fragment of left valve. ½ mile below Chapel Point.

Figs. 2, 2a. TELLINA WILLIAMSI Clark 167
2. Exterior of left valve. Potomac Creek.
2a. Interior of same specimen.

Fig. 3. TELLINA VIRGINIANA Clark 166
Exterior of left valve. Hanoverville, Va.

Fig. 4. MERETRIX LENIS (Conrad) 168
Exterior of right valve. Woodstock.

Figs. 5-9. MERETRIX SUBIMPRESSA Conrad 170
5. Exterior of right valve. Acad. Nat. Sci. Phila.
5a. Interior of same specimen.
6. Dorsal aspect of complete individual. Acad. Nat. Sci. Phila.
7. Exterior of left valve. Same collection.
8. Exterior of right valve.
8a. Interior of same specimen.
9. Interior of left valve.
9a. Exterior of same specimen.



MOLLUSCA—PELECYPODA.

d

PLATE XXXIV.

PAGE

Figs. 1, 1a. MERETRIX OVATA var. OVATA (Rogers) 168

1. Interior of right valve. West of Port Tobacco. × 2/7

1a. Exterior of same specimen.

Figs. 2-5. MERETRIX OVATA var. PYGA Conrad................ 169

2. Exterior of right valve.

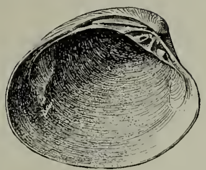
2a. Interior of same specimen.

3. Interior of left valve.

3a. Exterior of same specimen.

4. Exterior of right valve.

5. Exterior of left valve of young individual.



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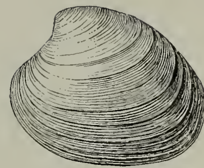

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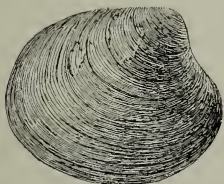

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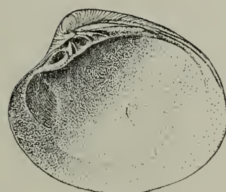
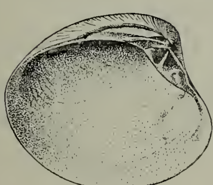


2a



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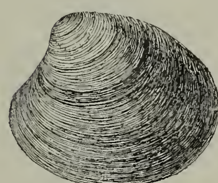

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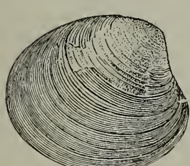

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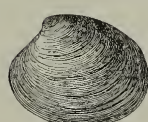


5

MOLLUSCA—PELECYPODA.

PLATE XXXV.

PAGE

Figs. 1a-1g. Dosiniopsis lenticularis (Rogers) 171

1a. Interior of left valve. Glymont.

1b. Interior of right valve. Same locality.

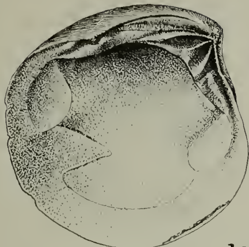
1c. Exterior of Fig. 1a.

1d. Exterior of Fig. 1b.

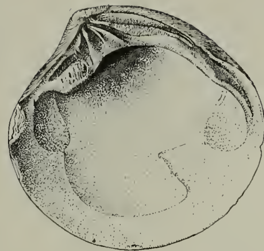
1e. Dorsal aspect of complete individual. Same locality.

1f. Interior of left valve. Same locality.

1g. Interior of right valve. Same locality.



1a



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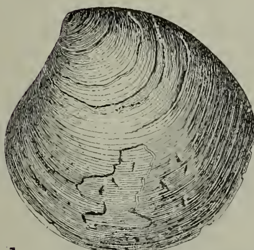

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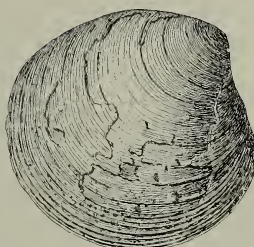

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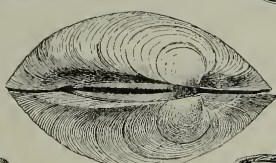

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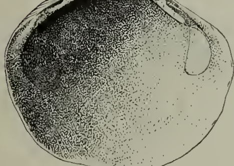

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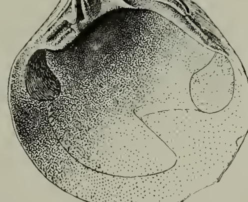


1g

MOLLUSCA—PELECYPODA.

PLATE XXXVI.

PAGE

Figs. 1-3. PROTOCARDIA LENIS Conrad 172

1. Exterior of right valve. 1 mile southeast of Mason Springs.

1a. Interior of same valve.

2. Interior of left valve. Pamunkey River, Va. Acad. Nat. Sci. Phila.

2a. Exterior of same valve.

3. Exterior of right valve from same locality and in same collection.

Fig. 4. DIPLODONTA MARLBOROENSIS n. sp. 173

Exterior of left valve. Upper Marlboro. × 7/4

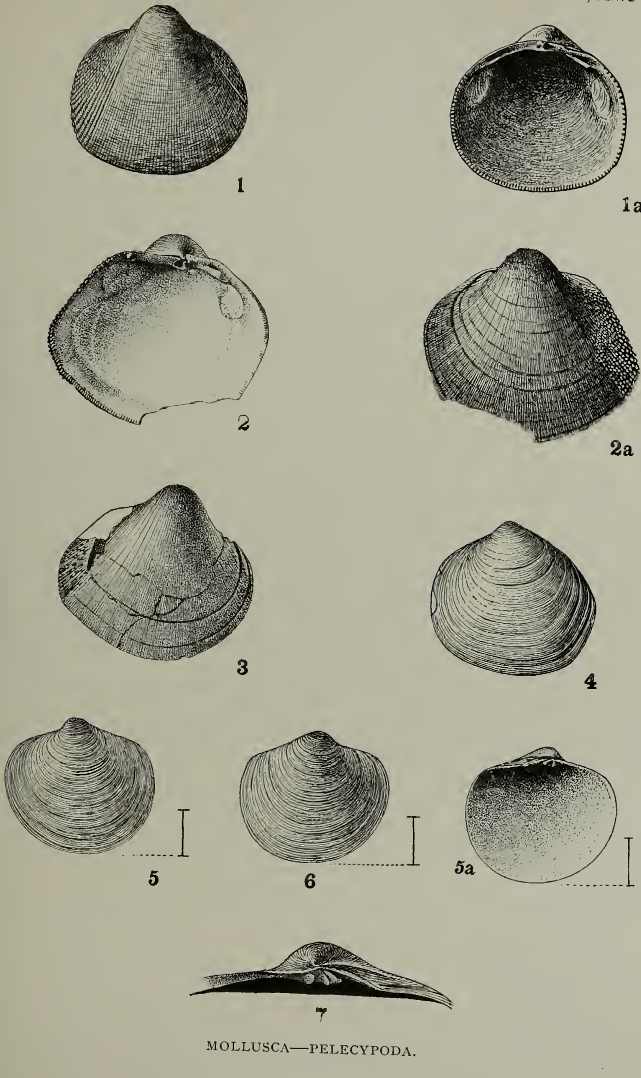
Figs. 5, 5a, 6, 7. DIPLODONTA HOPKINSENSIS Clark 174

5. Exterior of left valve. Evergreen, Va.

5a. Interior of same valve.

6. Exterior of right valve. Same locality.

7. Hinge much enlarged.



MOLLUSCA—PELECYPODA.

PLATE XXXVII.

PAGE

Figs. 1. 1a. LUCINA AQUIANA Clark 174

1. Exterior of right valve. Type specimen. Aquia Creek. U. S. National Museum.

1a. Interior of same valve.

Figs. 2, 2a. LUCINA ASTARTIFORMIS Aldrich 175

2. Interior of left valve. 1 mile southeast of Piscataway.

2a. Exterior of same valve.

Figs. 3, 3a, 3b. LUCINA DARTONI Clark 175

3. Interior of right valve of the type specimen. Woodstock.

3a. Exterior of same valve.

3b. Exterior of left valve of same individual.

Figs. 4-7. LUCINA UHLERI Clark 176

4. Exterior of right valve of type specimen. Woodstock.

5. Interior of right valve of specimen. 1 mile southeast of Mason Springs.

6. Interior of left valve. Same locality.

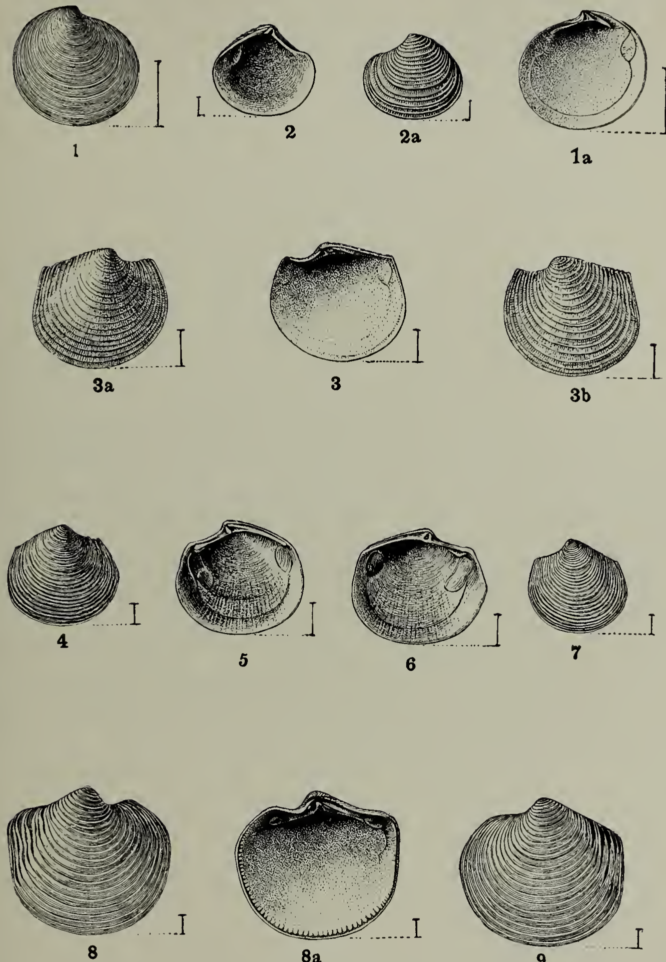
7. Exterior of left valve of type specimen. Woodstock.

Figs. 8, 8a, 9. LUCINA WHITEI Clark 176

8. Exterior of right valve of type specimen. Woodstock.

8a. Interior of same specimen.

9. Exterior of left valve of duplicate type. Same locality.



MOLLUSCA—PELECYPODA.

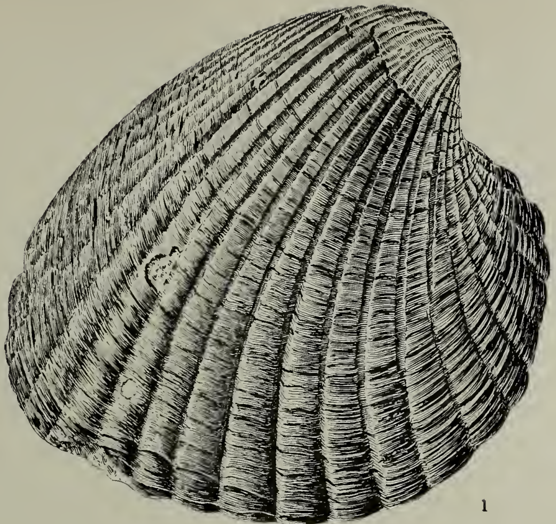
PLATE XXXVIII.

PAGE

Figs. 1, 1a. VENERICARDIA PLANICOSTA var. REGIA Conrad 178

1. Exterior of right valve. Upper Marlboro. Acad. Nat. Sci. Phila. × 9/10

1a. Interior of same valve.



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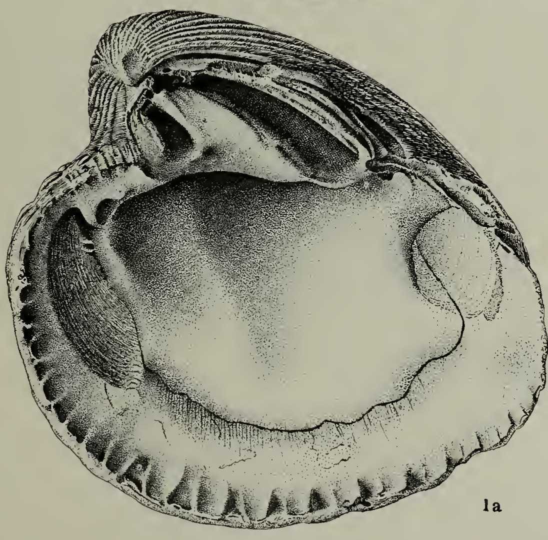


1a

MOLLUSCA—PELECYPODA.

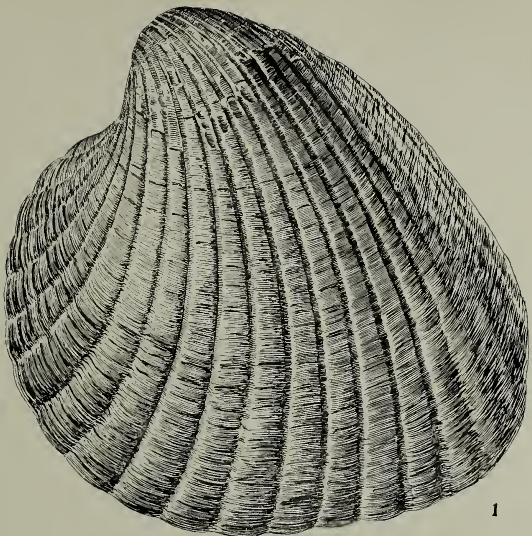
PLATE XXXIX.

PAGE

Figs. 1, 1a. VENERICARDIA PLANICOSTA var. REGIA Conrad 178

1. Exterior of left valve of individual figured on Plate XXXVIII. $\times$ 9/10.

1a. Interior of same valve.



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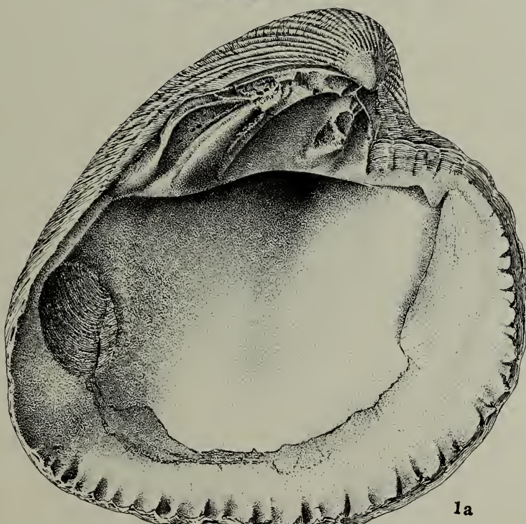


1a

MOLLUSCA—PELECYPODA.

PLATE XL.

PAGE

Figs. 1, 2, 3. VENERICARDIA PLANICOSTA var. REGIA Conrad 178

1. Anterior view of complete individual figured on Plates XXXVIII and XXXIX. Acad. Nat. Sci., Phila.
2. Exterior of left valve of very young individual.
3. Exterior of right valve of young individual.

Figs. 4-6. VENERICARDIA POTAPACOENSIS n. sp. 179

4. Exterior of left valve of type specimen. West of Port Tobacco.
5. Exterior of left valve.

5a. Interior of same specimen.

6. Exterior of right valve.

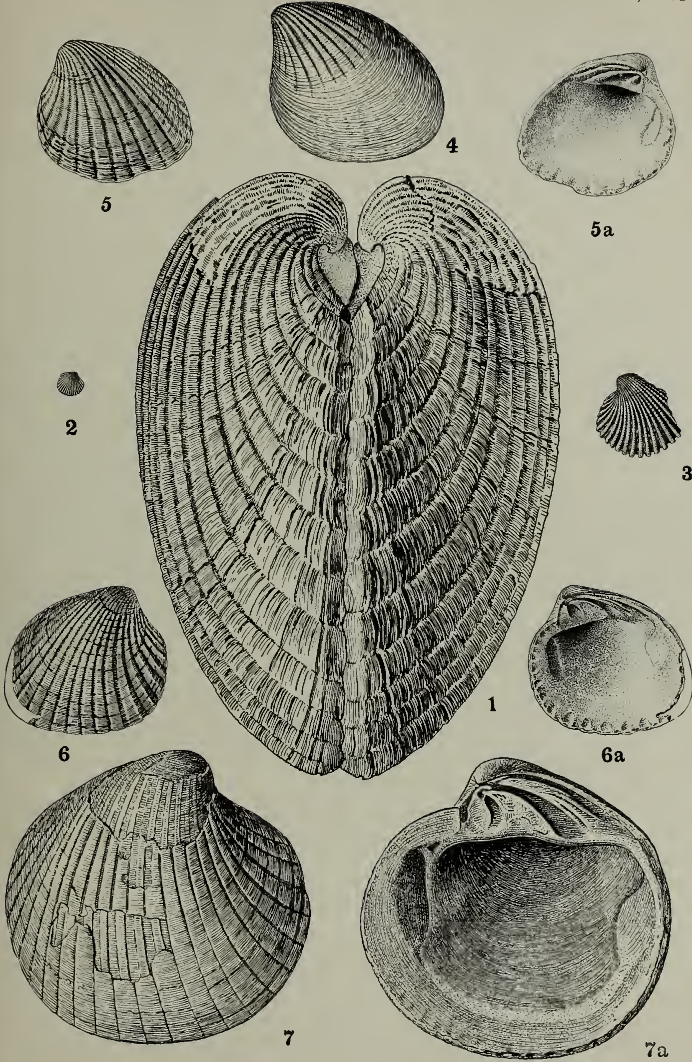
6a. Interior of same specimen.

Figures 5 and 6 are from specimens in the Philadelphia Academy of Natural Sciences. The locality of these specimens is in doubt, but they represent that form of *V. potapacoensis* which occurs typically in the Woodstock substage.

Figs. 7, 7a. VENERICARDIA MARYLANDICA n. sp. 179

7. Exterior of right valve of type specimen. 2¼ miles above Popes Creek.

7a. Interior of same specimen.



MOLLUSCA—PELECYPODA.

PLATE XLI.

PAGE

Figs. 1-8. CRASSATELLITES ALAEFORMIS (Conrad) 180

1. Exterior of the right valve of the type specimen of *C. declivis* Heilprin. Aquia Creek. U. S. National Museum. (After Aldrich.)
2. Exterior of the left valve of the same. (After Aldrich.)
3. Exterior of right valve. Fort Washington.

3a. Interior of the same.

4. Interior of left valve. Fort Washington.

4a. Exterior of the same.

5. Exterior of left valve.
6. Exterior of left valve. Fort Washington.

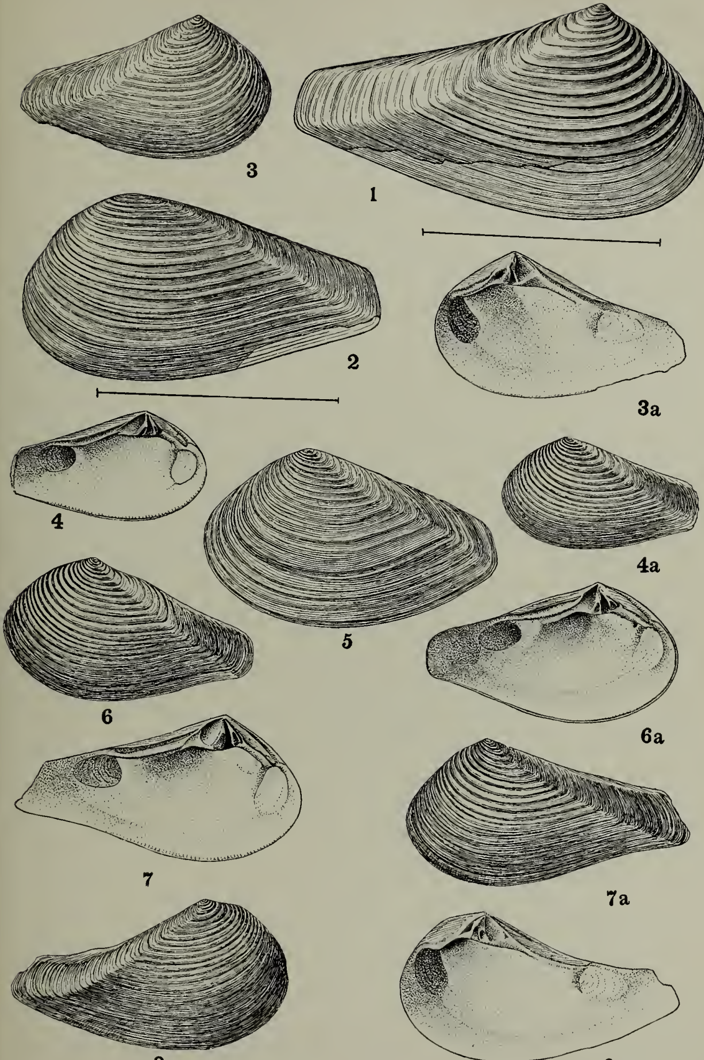
6a. Interior of the same.

7. Interior of left valve. Fort Washington.

7a. Exterior of the same.

8. Exterior of right valve. Fort Washington.

8a. Interior of the same.



MOLLUSCA—PELECYPODA.

PLATE XLII.

PAGE

Figs. 1, 2a, 2b. CRASSATELLITES AQUIANA (Clark) 181

1. Dorsal aspect of type specimen. Aquia Creek.

2a. Exterior of left valve of the same individual.

2b. Exterior of right valve of the same.

Fig. 3. CRASSATELLITES ALTA (Conrad) 182

Exterior of specimen. Hardesty.

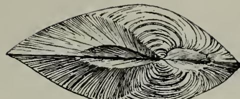
Figs. 4, 4a. CRASSATELLITES sp. 183

4. Exterior of right valve. Clifton Beach.

4a. Interior of the same.

Fig. 5. ASTARTE MARYLANDICA Clark 183

Exterior of left valve of type specimen. Upper Marlboro.



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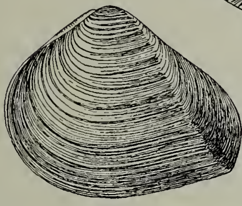
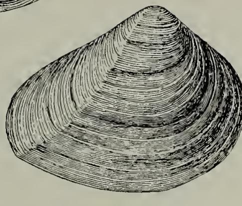


2a



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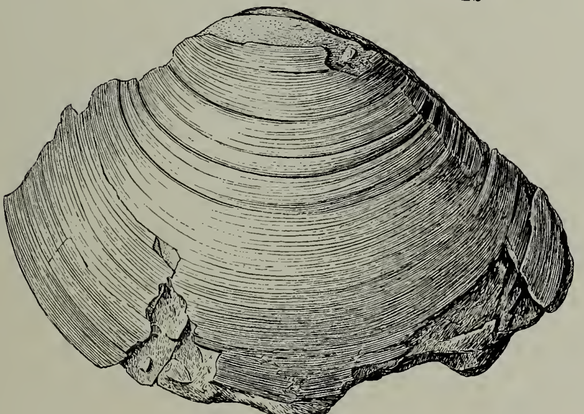

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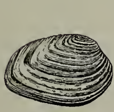


4

5

4a

MOLLUSCA—PELECYPODA.

PLATE XLIII.

PAGE

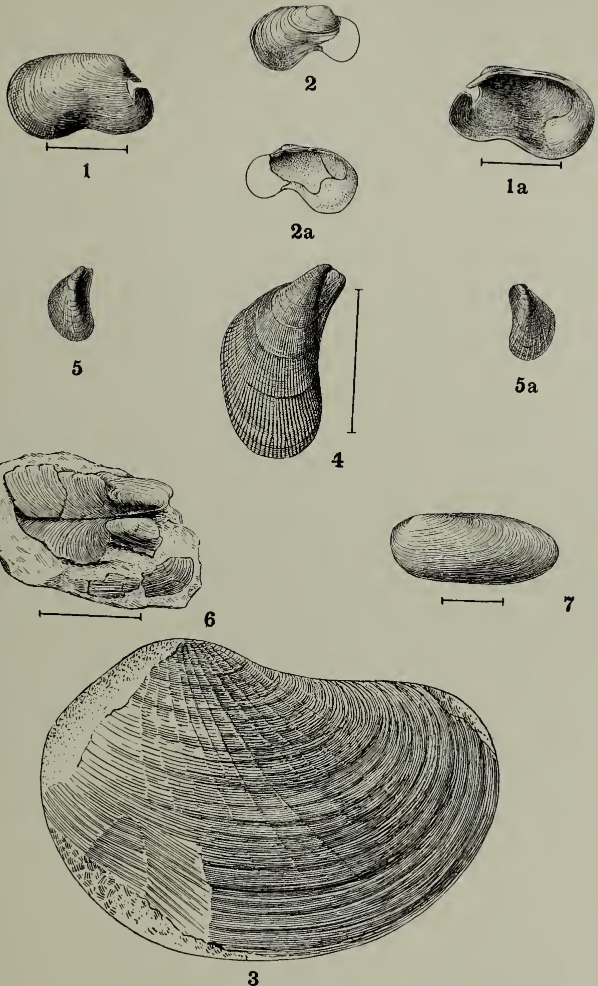
Figs. 1, 1a, 2, 2a. Coralliophaga (Oryctomya) bryani Clark.......... 183
1. Exterior of right valve. 1 mile southeast of Mason Springs.
1a. Interior of the same specimen.
2. Exterior of right valve of the type specimen. Pomonkey Neck. U. S. National Museum.
2a. Interior of the same specimen.

Fig. 3. Pholadomya marylandica Conrad 184
Exterior of left valve. Fort Washington. Acad. Nat. Sci. Phila.

Figs. 4, 5, 5a. Modiolus alabamensis Aldrich 185
4. Exterior of right valve. Mouth of Paspotansa Creek.
5. Exterior of right valve. Potomac Creek.
5a. Exterior of left valve of same individual.

Fig. 6. Modiolus marylandicus n. sp. 186
Dorsal aspect of crushed specimen. Woodstock.

Fig. 7. Lithophaga marylandica n. sp. 186
Exterior of left valve of type specimen. Clifton Beach.



MOLLUSCA—PELECYPODA.

PLATE XLIV.

PAGE

Figs. 1, 1a. ANOMIA MCGEEI Clark 187

1. Exterior of left valve of type specimen. Hanover Co., Va. Acad. Nat. Sci. Phila.

1a. Interior of the same.

Figs. 2, 2a, 3. ANOMIA MARYLANDICA n. sp. 187

2. Exterior of left valve. Popes Creek.

2a. Interior of the same.

3. Exterior of left valve. Same locality.

Figs. 4, 5, 6. PECTEN CHOCTAVENSIS Aldrich 188

4. Exterior of right valve. Popes Creek. The height of the original is 13.5 mm. instead of 11 mm. as the line indicates.

5. Exterior of left valve. Popes Creek.

6. Exterior of left valve of smaller individual. Same locality.

Figs. 7, 7a, 7b. PECTEN DALLI Clark 188

7. Exterior of right valve of type specimen. Potomac Creek.

7a. Hinge of the same. × 2

7b. Interior of the same.

Figs. 8, 8a. PECTEN JOHNSONI Clark 189

8. Exterior of left valve of type specimen. Potomac Creek.

8a. Interior of the same.

Figs. 9, 9a. PECTEN sp. 190

9. Interior of right valve. Potomac Creek.

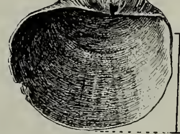
9a. Exterior of the same.

7

7a

2

3



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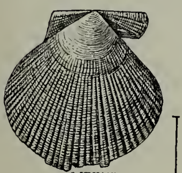

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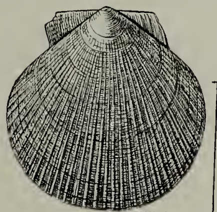

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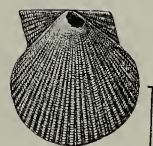


6

7

7a

7b

8

8a

9

9a

MOLLUSCA—PELECYPODA.

PLATE XLV.

PAGE

OSTREA COMPRESSIROSTRA Say 190

Lower valve of large individual. × ⅔

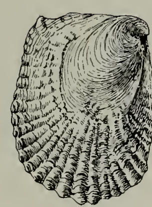
MOLLUSCA—PELECYPODA.

PLATE XLVI.

1

2a

2b

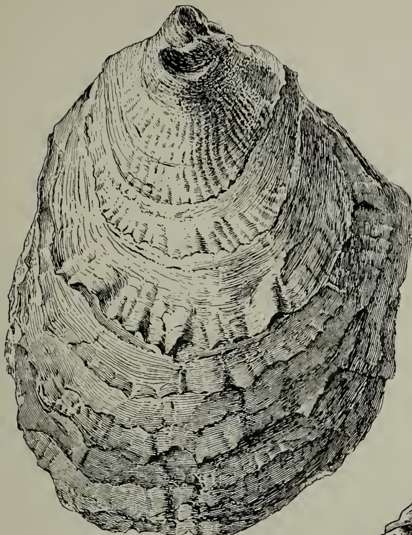


2c

MOLLUSCA—PELECYPODA.

PLATE XLVII.

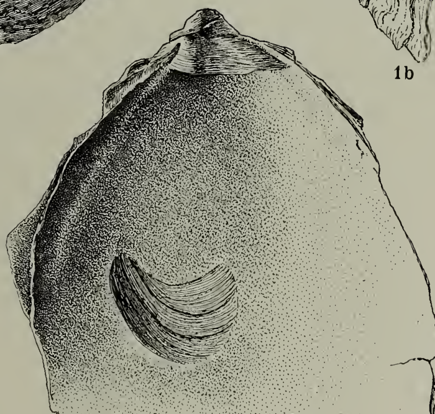
		PAGE
Figs. 1-4.	OSTREA COMPRESSIROSTRA Say	190
1.	Exterior of lower valve.	
1a.	Interior of the same.	
1b.	Lateral aspect of the same individual.	
2, 3, 4.	Exteriors of young upper valves.	



1

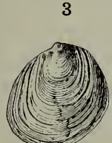
1b

2



1a

3



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MOLLUSCA—PELECYPODA.

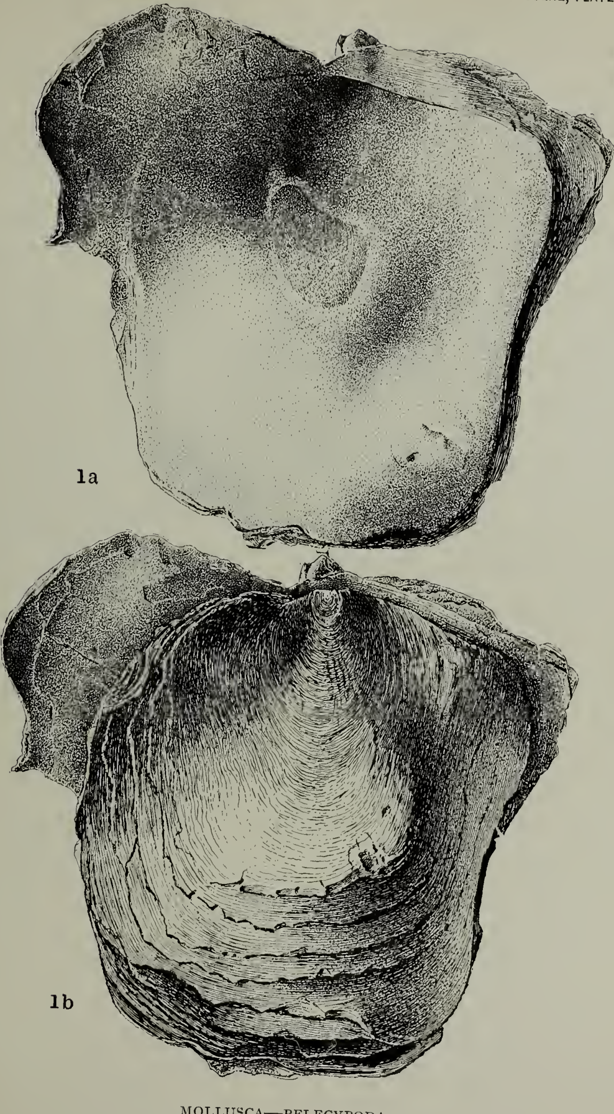
PLATE XLVIII.

PAGE

Figs. 1a, 1b. OSTREA SELLAEFORMIS Conrad 192

1a. Interior of lower valve. James River, Va.

1b. Exterior of upper valve of same individual with lower valve in position.



MOLLUSCA—PELECYPODA.

PLATE XLIX.

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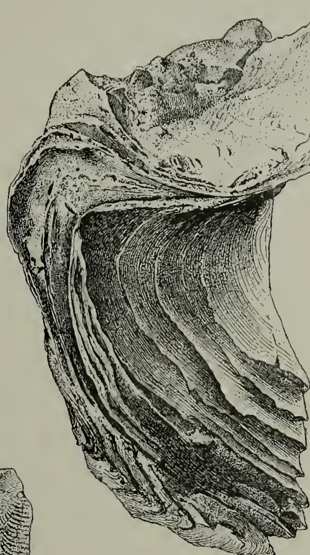
Figs. 1a-1d. OSTREA SELLAEFORMIS Conrad 192

1a. Lateral view of specimen figured on Plate XLVIII.

1b, 1c, 1d. Exteriors of lower valves of young individuals. James River, Va.



1a

1b

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1d

MOLLUSCA—PELECYPODA.

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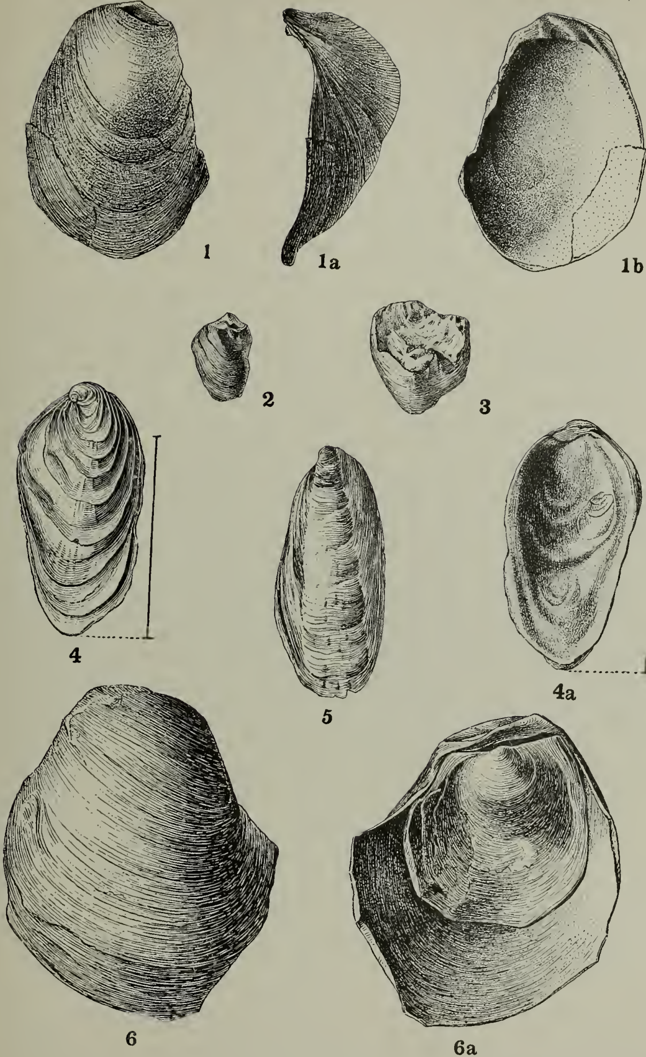

MOLLUSCA—PELECYPODA.

PLATE LI.

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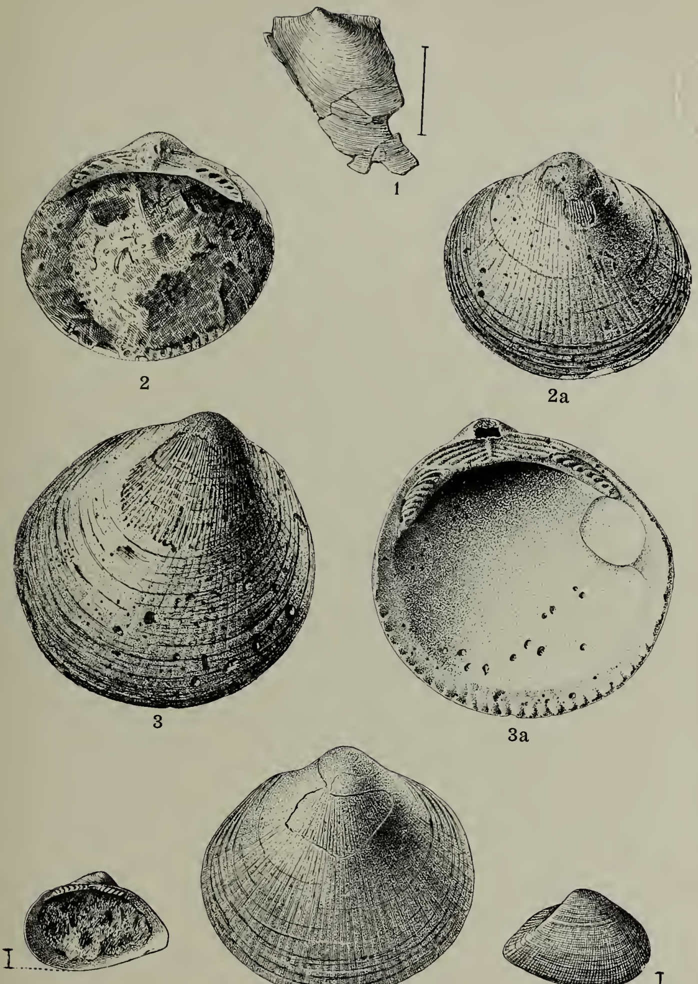
5. Interior of a right valve. Woodstock.
5a. Exterior of the same valve.



MOLLUSCA—PELECYPODA.

PLATE LII.

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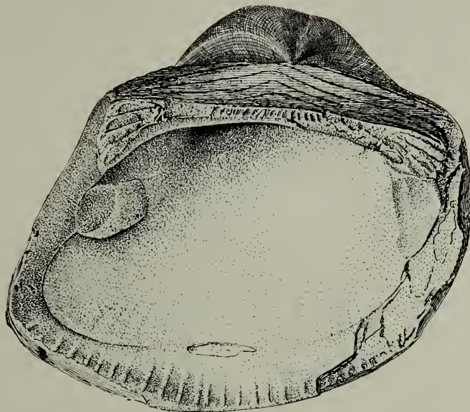
Figs. 1a, 1b. Cucullaea gigantea Conrad 196

1a. Interior of left valve. Potomac Creek.

1b. Exterior of same valve.



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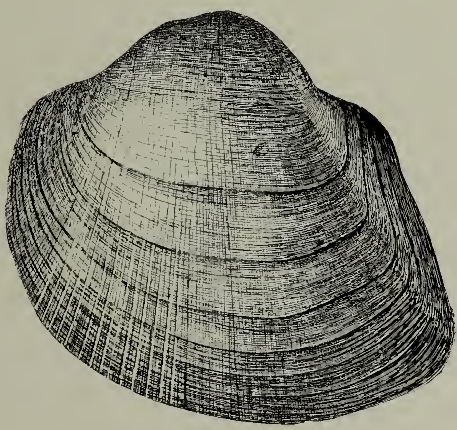

1b

MOLLUSCA—PELECYPODA.

PLATE LIII.

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Figs. 1a, 1b. CUCULLAEA GIGANTEA Conrad 196

1a. Interior of right valve of individual figured on Plate LII.

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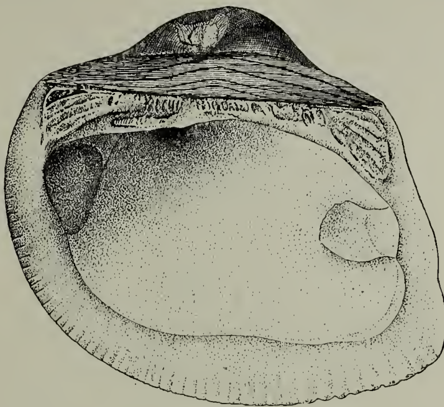

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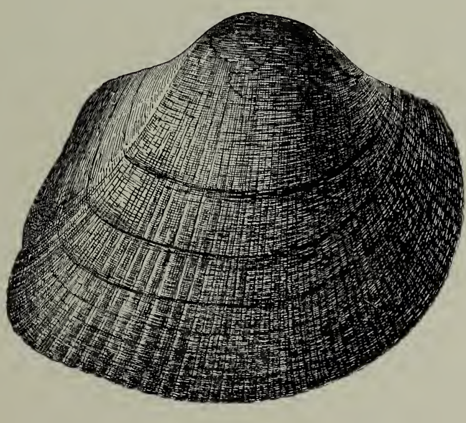

1b

MOLLUSCA—PELECYPODA.

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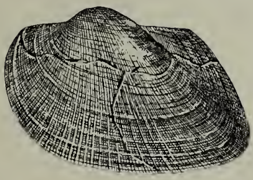
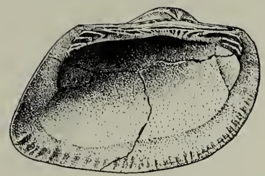
1a. Exterior of left valve of young of the *transversa* type. Potomac Creek.

1b. Interior of the same valve.

1c. Dorsal aspect of large cast. Fort Washington.


1a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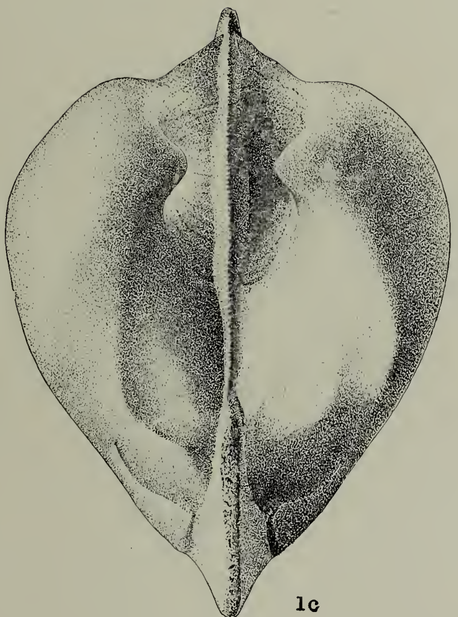
1c

MOLLUSCA—PELECYPODA.

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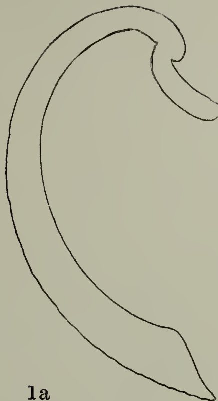
1a, 1b. Diagrams showing transverse section of the individual figured on Plates LII and LIII.

1c. Lateral aspect of the individual figured on Plate LIV, Fig. 1c.



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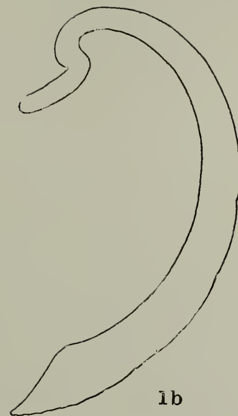

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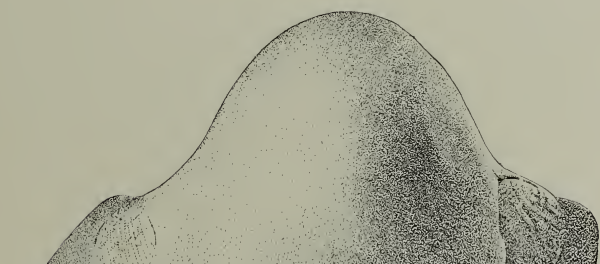

1c

MOLLUSCA—PELECYPODA.

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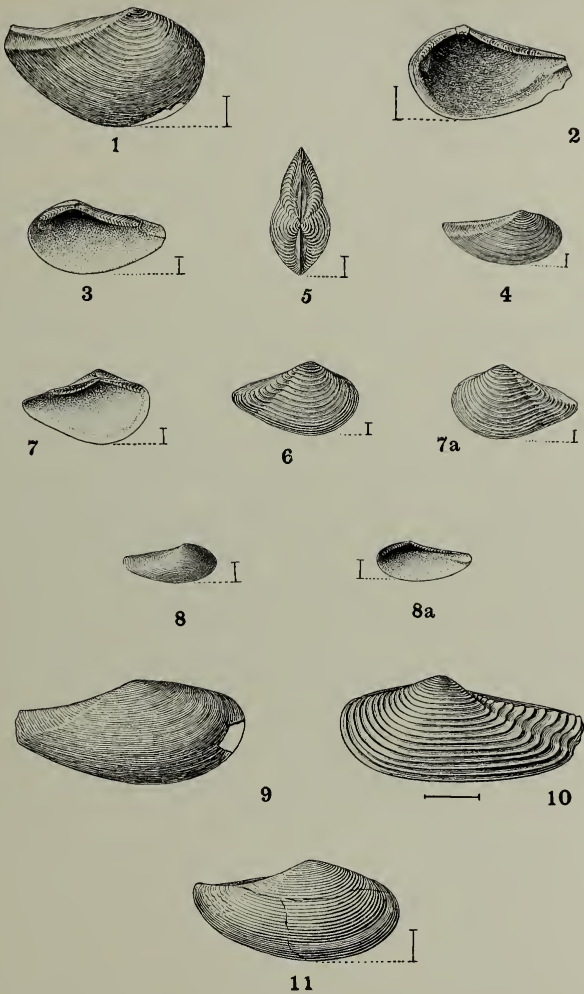

MOLLUSCA—PELECYPODA.

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7a. Exterior of same valve.	
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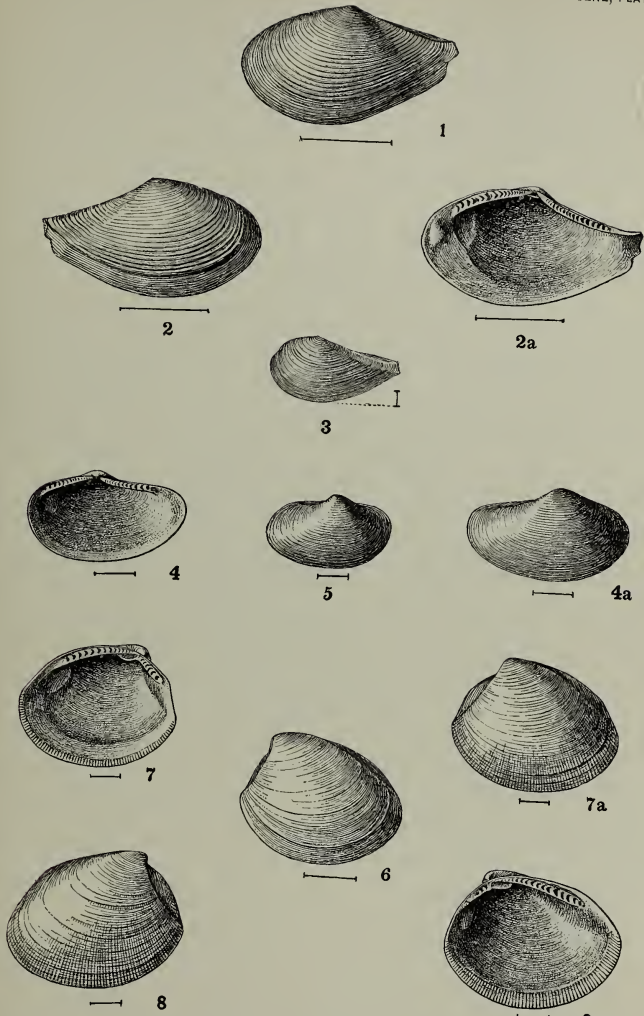

MOLLUSCA—PELECYPODA.

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1. Exterior of ventral valve. Upper Marlboro.
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2. Interior of ventral valve. 3 miles west of Leeland. × 4/9
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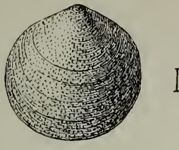

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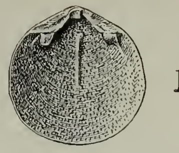
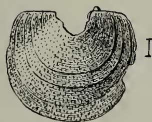


1a



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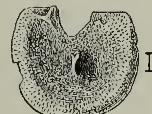

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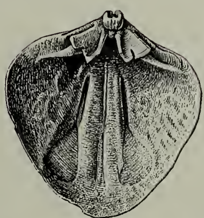

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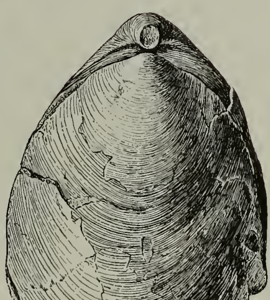
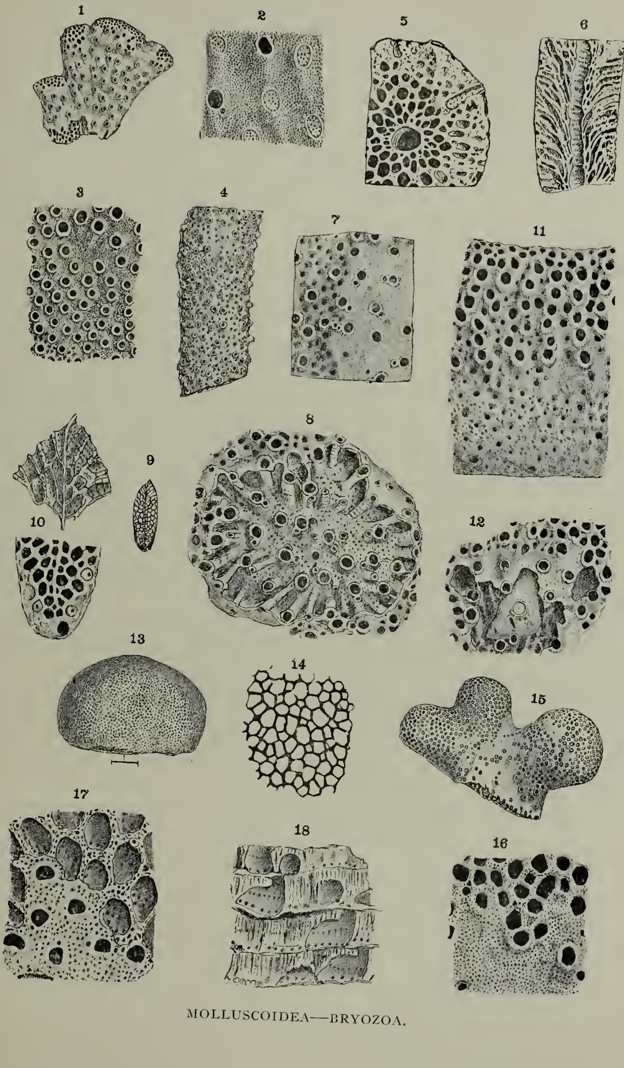


3a

MOLLUSCOIDEA—BRACHIOPODA.

PLATE LIX.



MOLLUSCOIDEA—BRYOZOA.

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Fig. 14. Cribrilina crassula n. sp. 218

14. Portion of the somewhat worn specimen described. Upper Marlboro. × 20

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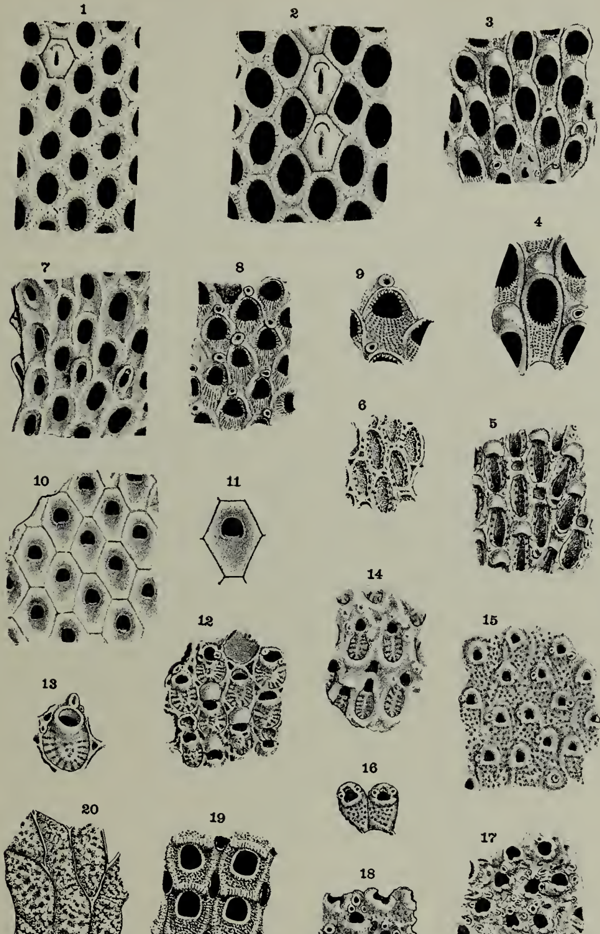

MOLLUSCOIDEA—BRYOZOA.

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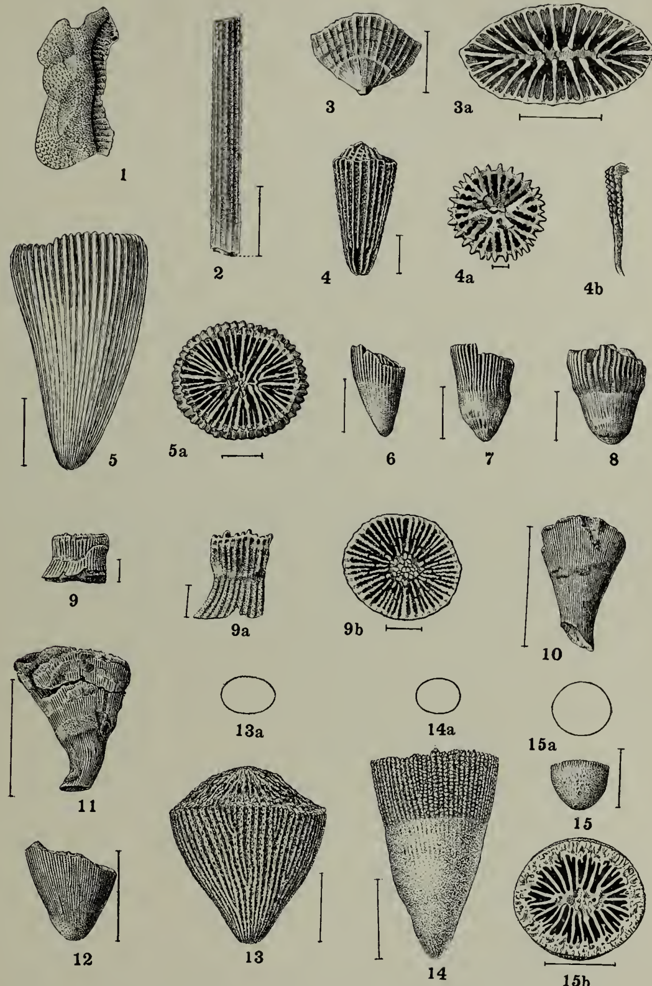

ECHINODERMATA AND COELENTERATA.

PLATE LXII.

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Fig. 1. TEXTULARIA GRAMEN d'Orbigny 233
1 mile northeast of Piscataway. × 50

Fig. 2. TEXTULARIA SAGITTULA Defrance 234
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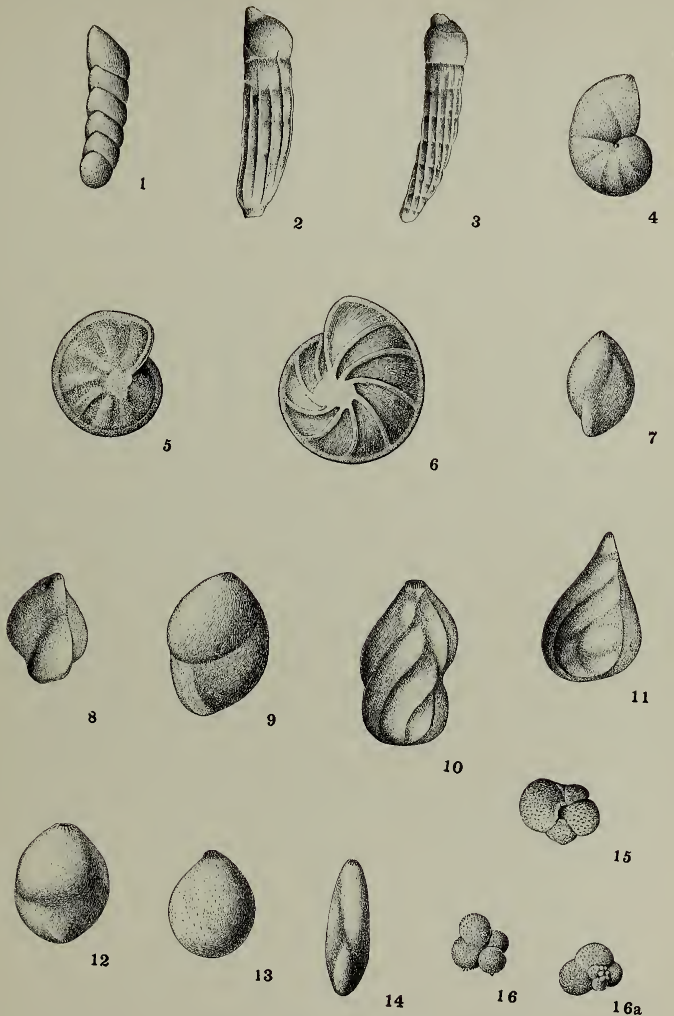
PROTOZOA—FORAMINIFERA.

PLATE LXIII.



PROTOZOA—FORAMINIFERA.

PLATE LXIV.

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Fig. 1. Discorbina bertheloti (d'Orbigny) 251
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Fig. 2. Discorbina turbo (d'Orbigny) 251
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12a. Entire fruit, side view.
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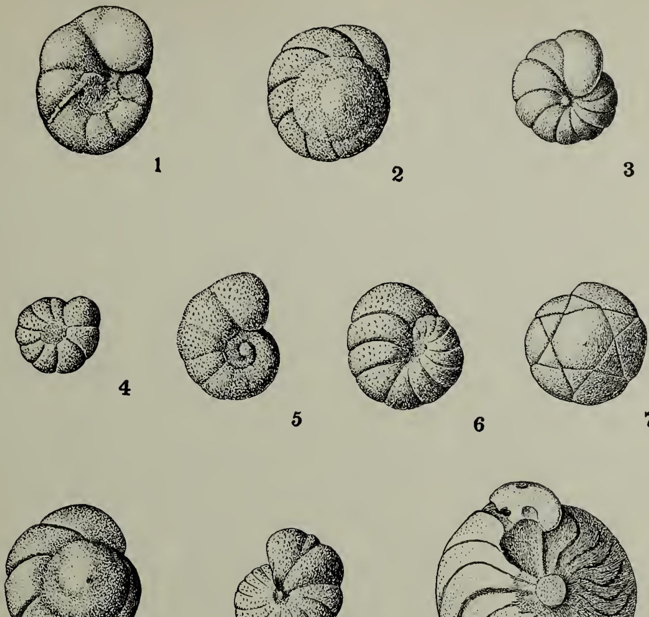

PROTOZOA—FORAMINIFER, AND PLANTAE.

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R.

S.

PALEONTOLOGICAL INDEX

R.

S.

ERRATA.

PAGE			
61	line 10	for	*Odotus obliquus* read *Otodus obliquus.*
63	" 14	"	*Reticulipora dichomata* read *Reticulipora dichotoma.*
63	" 36	"	*Marginula costata* read *Marginulina costata*
63	" 43	"	*Fissuridea marylandica* read *Fissuridea marlboroensis*
80	" 35	"	*Marginula costata* read *Marginulina costata*
81	" 35	"	" " " " "
82	" 14	"	*therefore* read *their*
Plate XX		"	*Cephalopoda* read *Gastropoda.*